UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

HAZARDOUS
SITE CONTROL
DIVISION

Remedial Planning/ Field Investigation Team (REM/FIT)

ZONE II

CONTRACT NO.
68-01-6692

CH2M HILL

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June 19, 1986

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Mr. Larry Rexroat, RPM
Environmental Protection Agency
Region VI
InterFirst Two Building
1201 Elm Street
Dallas, Texas 75270

Dear Larry:

We are pleased to submit thirty (30) copies of the Final Offsite Feasibility Study for the Vertac site. Additional copies are distributed as indicated below.

The report has been revised to address your oral comments of June 3.

Sincerely,

Richard G. Saterdal

Richard G. Saterdal, P.E.
Site Project Manager

DE/VERTC7/038/nkm
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EXECUTIVE SUMMARY

This feasibility study (FS) presents and evaluates remedial action alternatives for offsite areas adjacent to the Vertac Chemical Corporation plant, Jacksonville, Arkansas, which were found to be contaminated with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) during the Remedial Investigation (RI). The sites are shown in Figures 1 and 2.

BACKGROUND

Herbicides of which TCDD is a by-product have been produced at the Vertac site over the last 30+ years. Herbicide wastes which contained TCDD were discharged into the sanitary sewer and into Rocky Branch, a small watercourse that flows into Bayou Meto. Subsequently the downstream wastewater treatment facilities, Bayou Meto, and flood plains of Rocky Branch and Bayou Meto became contaminated with TCDD. Attention was first focused on the Vertac site as a possible source of TCDD contamination after the National Dioxin Survey of 1978. Since then several investigations, including the RI, have confirmed TCDD-contamination in the wastewater facilities (a sanitary sewer system, an old sewage treatment plant which is now abandoned, and active aeration pond and oxidation basins); in two waterways which drain this area and receive treated wastewater effluent (Rocky Branch and Bayou Meto); and in the flood plains adjacent to these waterways.

ACTION LEVEL

The agency for Toxic Substances and Disease Registry (ATSDR) reviewed data for the Vertac offsites. Based on the ATSDR recommendations for TCDD remediation at the site, the following action levels were assumed for the various contaminated areas:

- o Wastewater Collection System. The sewer lines that were indicated in the RI to have TCDD concentrations equal to or greater than 1 ppb would be remediated. This action level was chosen because the contaminants in the sewer line could migrate downstream and contaminate the wastewater treatment facilities, Bayou Meto, and nearby flood plains.

- o Old Sewage Treatment Plant. The TCDD-contaminated sludges, wastes, soils, and sediments in the abandoned facilities would be remediated. The surface soils around the abandoned sewage treatment facilities would be remediated so that an action level of 1 ppb TCDD is not exceeded. The ATSDR recommended, however, an action level of 5 to 7 ppb TCDD for soils in and around the abandoned sewage treatment facilities if the following conditions were imposed: (1) the site was not developed for agricultural or residential use, (2) the use and activities of the site must not become associated with the production, preparation, handling, consumption, or storage of food, other consumable items, or food packaging materials, and (3) the site soils must be protected from erosion that would uncover or transport TCDD that could cause unacceptable human exposure at a future date. Therefore, the assumed level of remediation of the old sewage treatment plant area is greater than recommended by ATSDR. However, including areas with TCDD levels of 1 to 5 ppb has little impact on the total quantities and costs for the remedial actions proposed for the wastewater facilities.

- West Wastewater Treatment Plant. The aeration pond, oxidation basins, outfall ditch, and the peripheral land that has TCDD levels exceeding 5 ppb TCDD and that would be zoned for manufacturing would be remediated.

- Rocky Branch and Bayou Meto. An action level of 1 ppb TCDD would apply to the sediments and soil in and immediately adjacent to the Rocky Branch and Bayou Meto channels.

- Flood Plain--Residential and Agricultural. A 1-ppb-TCDD action level would be adopted for residential and agricultural areas.

- Flood Plain--Nonresidential and Nonagricultural. Nonresidential and nonagricultural areas in the flood plain (such as woodlands, industrial, and commercial areas) that are not subject to erosion and transport processes would have an action level of 5 ppb TCDD. If the areas are subject to erosion and transport processes then the action level would be 1 ppb. (The flood plain is defined not to be subject to erosion and transport processes if the area has sufficient ground cover to inhibit erosion.

Using the previously identified action levels and information from the RI and the RI team, the volumes of contaminated material assumed to be remediated were estimated. The amount of contaminated material at a given level could be better defined with additional testing, such as fine-grid sampling that was recommended by ATSDR, prior to implementing a remedial action. The flood plain and waterways could also be modelled to estimate sediment desposition areas.

In order to illustrate how remedial costs would vary at other levels of cleanup, a sensitivity analysis was performed.

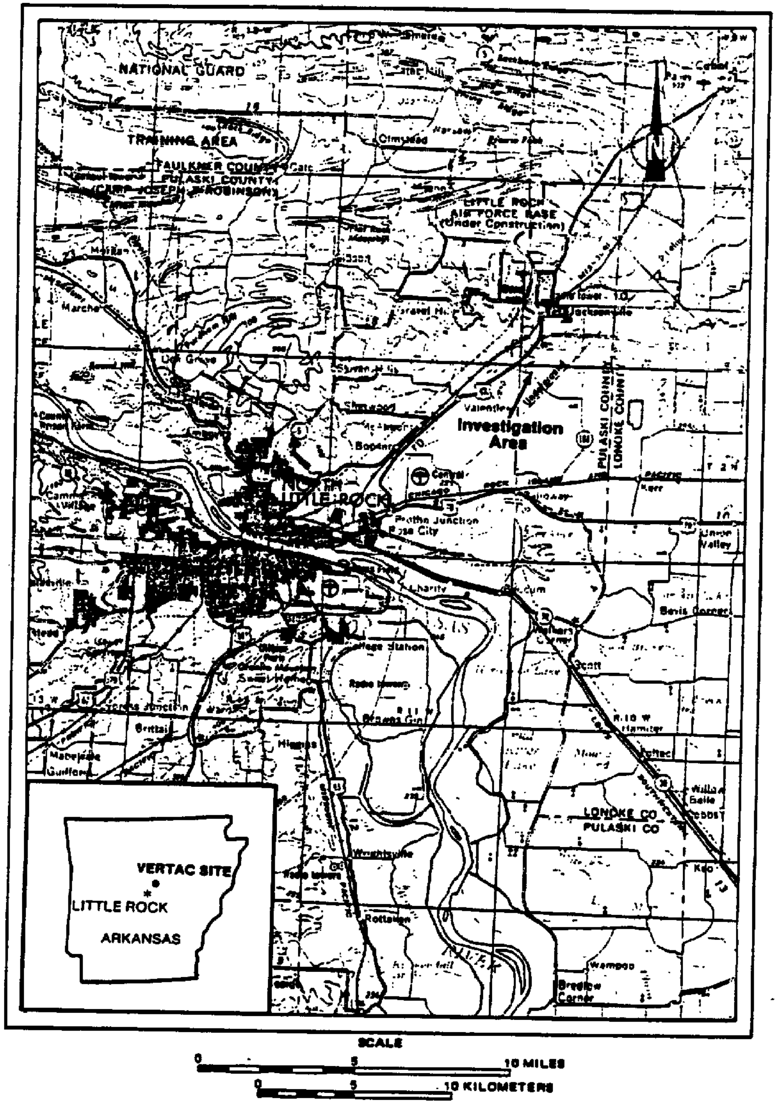
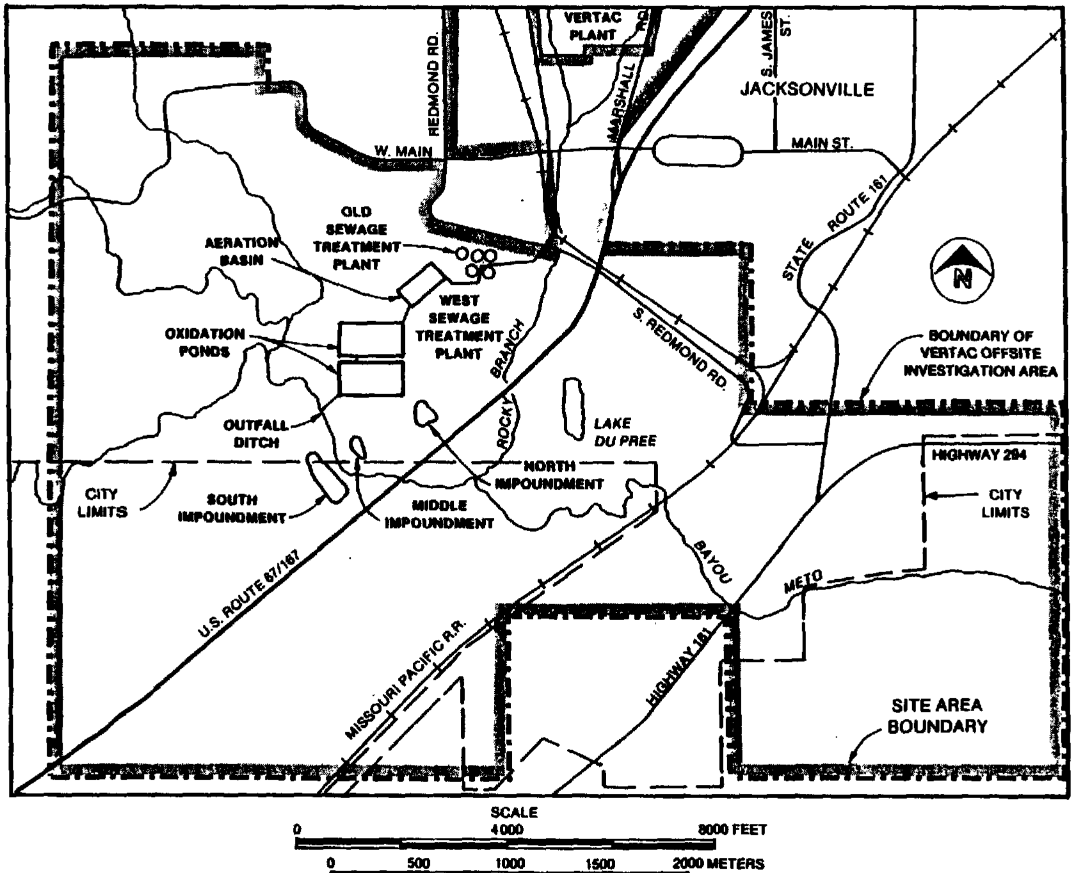


Figure 1
Site Location Map



Source: Offsite Remedial Investigation Final Report (U.S. EPA, December 1, 1985)

Note: In the future, the extent of remediation may extend beyond the boundaries shown for the Vertac offsite investigation area.

Figure 2
Offsite Investigation Area

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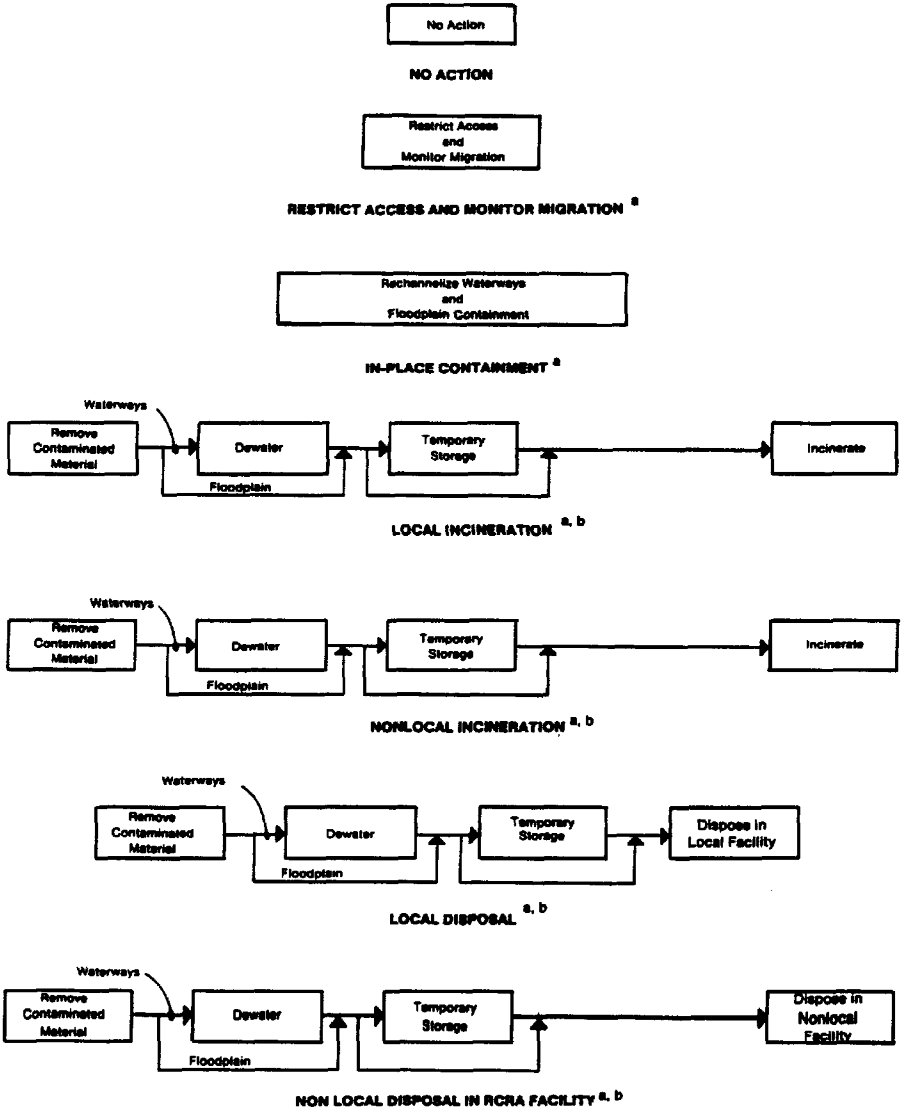
REMEDIAL ALTERNATIVES

Remedial alternatives were developed separately for the two major contaminated areas--the waterways and flood plain and the wastewater facilities. The technologies selected for these alternatives were assembled for the purpose of making comparative evaluations and cost estimates.

Figures 3 and 4 summarize the waste management steps for the alternatives developed for each of the major contaminated areas. Tables 1 and 2 summarize the descriptions and evaluations of the alternatives. The cost estimates presented in these tables are order-of-magnitude estimates as defined by the American Association of Cost Engineers, with an expected accuracy of +50 to -30 percent. The feasibility level cost estimates shown have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope, final project schedule, the firm selected for final engineering design, and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

Seven alternatives, including a no action alternative, were developed for the waterways and floodplain. Three of the alternatives included leaving the contaminated materials in place and four of the alternatives included removing the contaminated materials and then either incinerating or disposing in permanent facilities. The estimated times for implementing the alternatives, excluding the no action alternative, ranged from 4 years for restricting access to 7 years for local incineration. (The implementation time refers to the time from when design of the remedial alternative commences to when the remediation actions are complete--except for ongoing maintenance and monitoring). The present worth of the implementation costs were estimated to range from \$1.4 to \$160 million, again excluding the no action alternative which has no cost associated with it. The most costly alternatives were the alternatives requiring incineration followed by the ultimate disposal alternatives.

Seven alternatives, including a no action alternative, were developed for the wastewater facilities. Two of the alternatives included leaving the contaminated materials in-place and five of the alternatives included removing the contaminated materials and then either incinerating or disposing in permanent facilities. The estimated implementation times, 3-5 years, did not vary much for the different alternatives. The present worth of the implementation costs were estimated



[a] These alternatives include a mobile water treatment facility.
[b] These alternatives include a fixed water treatment facility.

Figure 3
Waste Management Steps for Remedial Alternatives
Waterways and Floodplain

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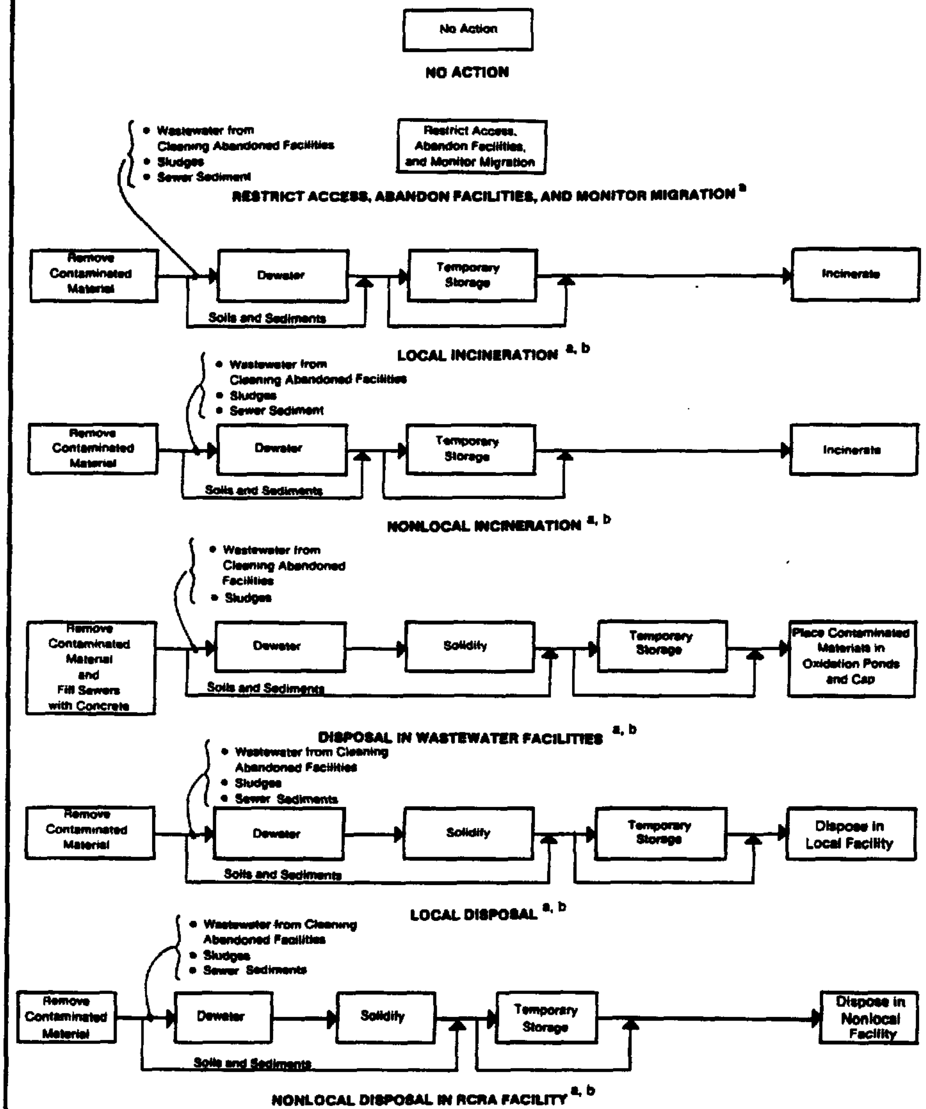

[a] These alternatives include a mobile water treatment facility.
[b] These alternatives include a main water treatment facility.

Figure 4
Waste Management Steps for Remedial Alternatives
Wastewater Facilities

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Table 1
SUMMARY OF REMEDIAL ALTERNATIVES
WATERWAYS AND FLOOD PLAIN

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time, Years[b]	Total Capital Cost, $Million	Total Present Worth, $Million
1. NO ACTION No actions would be taken at the site.	5 - No action	Easiest alternative to implement	Does not reduce exposure to or migration of TCDD	0	0	0
2. RESTRICT ACCESS AND MONITOR MIGRATION Access to waterways and flood plain would be restricted by fences, signs, and public awareness programs. Future extent of TCDD contamination will be monitored by soil/sediment sampling and with wells. LENGTH OF WATERWAYS: Bayou Meto--6,450 ft Rocky Branch--3,700 ft AREA OF FLOOD PLAINS: 23 ac	4 - Meets CERCLA goals but does not meet standards.	More economical and easier to implement than Alternatives 3-7. Deters recreational and agricultural use of creeks and flood plain, thus reducing potential for exposure; deters consumption of contaminated fish, a primary public health concern.	Restricted usage would apply to several miles along the waterways, resulting in a substantial loss of acreage. Land use patterns may change. TCDD-migration into accessible areas--downstream channel, flood plains, and air--is not reduced.	4	1.6	1.4
3. IN-PLACE CONTAINMENT A new channel for part of Rocky Branch and Bayou Meto would be constructed. The contaminated material in the old channel would be buried with soil. The contaminated flood plains would be covered with geotextiles and 12 in. of topsoil. Flood control berms would be constructed to reduce erosion. Long-term maintenance required. LENGTH OF WATERWAYS: Bayou Meto--6,450 ft Rocky Branch--3,700 ft AREA OF FLOOD PLAINS: 23 ac	4 - Meets CERCLA goals but does not meet standards.	Cover reduces exposure of TCDD to public and environment. Reduction in TCDD-bioaccumulation by aquatic life that is consumed by humans. Eventually normal activities can resume in waterways and flood plain.	Placement of geotextile and topsoil around the trees in the flood plain will be difficult. Floodplain will have to be regularly inspected and maintained to prevent uncovering of contaminated soil. Existing aquatic ecosystem and the terrestrial environment will be destroyed within the remediation area.	4	4.6	3.8

1X

Table 1
(continued)

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time,[b] Years	Total Capital Cost, $Million	Total Pre Worth, $M
4. LOCAL INCINERATION The contaminated materials would be removed, the waterway sediments dewatered using windows, and the material incinerated at an incinerator located onsite. Quantity of material (in-place contaminated volumes): Bayou Meto--17,800 yd^3 Rocky Branch--5,700 yd^3 Floodplain--37,600 yd^3	2-attains standards[c]	Destruction of TCDD eliminates potential for future human and environment exposure. No restrictions on future and land use Mobile incinerators have been shown to have TCDD DRE's of greater than 99.9999 percent. These incinerators or ones similar to them would probably be available for use at this site.	Air emissions may present an exposure hazard if destruction of TCDD is incomplete. Public concern about waste incinerator in their "backyard." Removing materials may be difficult due to site conditions including dense forest, no existing roads to most of the contaminanted areas, and possibly unstable soils.	7	160	160
5. NONLOCAL INCINERATION The contaminated materials would be removed, the waterway sediments dewatered using windows, and the materials hauled to a nonlocal incineration facility. Quantity of Materials (in-place contaminated volumes): Bayou Meto--17,800 yd^3 Rocky Branch--5,700 yd^3 Floodplain--37,600 yd^3	1-RCRA offsite facility and 2-attains standards[c]	Destruction of TCDD eliminates potential for future human and environment exposure. No restrictions on future land use. Incineration with DRE's greater than 99.9999 percent has been demonstrated.	Air emissions may present an exposure hazard if destruction of TCDD is incomplete. Removing materials may be difficult due to site conditions including dense forest, no existing roads to most of the contaminated areas, and possibly unstable soils. Potential for hazardous waste spillage during hauling increases with haul distance. Currently there is no nonlocal, permanent incinerator which is permitted for TCDD destruction.	7	220	140

Table 1
(continued)

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time, Years[b]	Total Capital Cost, $Million	Total Pre[sent] Worth, $M[illion]
6. LOCAL DISPOSAL The contaminated materials would be removed, the waterway sediments dewatered using windows, and the materials disposed in an RCRA-design facility built onsite. Quantity of Materials (in-place contaminated volumes): Bayou Meto--17,800 yd^3 Rocky Branch--5,700 yd^3 Floodplain--37,600 yd^3	2-attains standards[c]	Containment effectively removes TCDD from public and environment exposure. No restrictions on future land use. their "backyard".	Failure of disposal facility could result in contamination of adjacent and downstream flood plains. Public concern about disposal facility in their "backyard". Removing materials may be difficult due to site conditions including dense forest, no existing roads to most of the contaminated areas, and possibly unstable soils. Suitability of site for permanent disposal facility is uncertain due to location in floodplain and possibly soil conditions. Future acceptance by regulatory agencies of disposing TCDD wastes is uncertain.	5	65	49
7. NONLOCAL DISPOSAL IN RCRA FACILITY The contaminated materials would be removed, the waterway sediments dewatered using windows, and the materials hauled to a nonlocal disposal facility. Quantity of Materials (in-place contaminated volumes): Bayou Meto--17,800 yd^3 Rocky Branch--5,700 yd^3 Floodplain--37,600 yd^3	1-RCRA offsite facility and 2-attains standards[c]	Containment effectively removes TCDD from public and environment exposure. No restrictions on future land use.	Currently there is no disposal facility peredmitted to accept TCDD waste. Future acceptance by regulatory agencies of disposing TCDD wastes is uncertain. Removing materials may be difficult due to site conditions including dense forest, no existing roads to most of the contaminated areas, and possibly unstable soils. Potential for hazardous waste spillage during hauling increases with haul distance.	5	79	55

[a]The EPA categories are alternatives that: (1) use a RCRA offsite facility, (2) attain standards, (3) exceed standards, (4) meet CERCLA goals but do not meet standards, and (5) require no ac[tion]. These categories are further discussed in the "National Oil and Hazardous Substances Contingency Plan" (November 20, 1985, Federal Register).

[b]The implementation time referes to the time from when design of the remedial alternative commences to when the remediation actions are complete--except for ongoing maintenance and monitoring

[c]These alternatives could fall under EPA categories 3 or 4 by varying the cleanup level. The cleanup level is varied in the sensitivity analysis presented in Section 8.

NOTES:

Costs in 1986 dollars.
Discount rate=10%.

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Table 2
SUMMARY OF REMEDIAL ALTERNATIVES
WASTEWATER FACILITIES

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time, Years[b]	Total Capital Cost[c], $Million	Total Present Worth[c], $Million
1. NO ACTION No actions would be taken at the site.	5 - No action	Easiest alternative to implement.	Does not reduce exposure to or migration of TCDD.	0	0	0
2. RESTRICT ACCESS, ABANDON FACILITIES, AND MONITOR MIGRATION. The sewer lines would be plugged and a new sewer line installed; use of the aeration pond and oxidation basins would be discontinued; access to the old and west sewage treatment plants would be restricted with fencing, signs, and public awareness programs; TCDD-contamination would be monitored with soil/sediment sampling and wells.	4 - Meets CERCLA goals but does not meet standards	More economical and easier to implement than Alternatives 3-7. Potential for human exposure is reduced. Migration of TCDD into the waterways would be reduced.	The possibility of exposure to TCDD via inhalation of airborne TCDD-particulates or consumption of contaminated groundwater is not reduced. Undesirable TCDD-migration may occur undetected.	5	1.9	1.7
3. LOCAL INCINERATION The contaminated materials in the sewer lines would be removed primarily by hydraulic flushing (Alternative A) or by completely removing the sewer line and pipe zone material (Alternative B); the contaminated material in the basins in the old sewage treatment plant would be washed out and the contaminated soil in the drying beds and out-fall ditch removed; the wastewater in the aeration pond and oxidation basins would be pumped out and the outfall ditch excavated. The contaminated sediment/slurries and wastewaters would be dewatered with a polyethylene wedge-wire drying bed system The contaminated materials would be incinerated at a facility located onsite. Quantity of Material to be Incinerated: 33,500 tons (Alt. A) 42,200 tons (Alt. B)	3-exceeds standards	Destruction of TCDD eliminates potential for future human and environment exposure. No restrictions on future use of facilities and land. Mobile incinerators have been shown to have TCDD DRE's of greater than 99.9999 percent. These incinerators or ones similar to them would probably be available for use at this site.	Air emissions may present an exposure hazard if destruction of TCDD is incomplete. Public concern about waste incinerator in their "backyard."	5	120 (140)	83 (97)

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Table 2
(continued)

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time, Years[b]	Total Capital Cost[c], \$Million	Total Present Worth[c], \$Million
4. NONLOCAL INCINERATION Same as above except contaminated material would be hauled to a nonlocal incinerator facility. Quantity of Material to be Incinerated: 33,500 tons (Alt. A) 42,200 tons (Alt. B)	1-RCRA offsite facility and 3-exceeds standards	Destruction of TCDD eliminates potential for future human and environment exposure. No restrictions on future use of facilities and land. Incineration with DRE's greater than 99.9999 percent had been demonstrated.	Air emissions may present an exposure hazard if destruction of TCDD is incomplete. Potential for hazardous waste spillage during hauling increases with haul distance. Currently there is no nonlocal, permanent incinerator which is permitted for TCDD destruction.	5	110 (130)	78 (90)
5. DISPOSAL IN WASTEWATER FACILITIES Sewer lines would be completely filled with concrete; contaminated materials in old and west sewage treatment plant would be removed and consolidated in a portion of the existing oxidation basins which would be capped. The wastewater sludges would be dewatered and solidified prior to containment in oxidation basins. Length of Sewer line to be Filled: 14,700 ft Quantity of Material to be Stored: 48,000 yd^3	4 - Meets CERCLA goals but does not meet standards.	Risk of TCDD-exposure to public and environment is reduced. Migration of TCDD is reduced, especially into waterways. Use of the aeration pond could possibly be resumed.	Adequacy of site for containing materials underground is unknown. Concerns include being located in flood plain and interactions with soil/groundwater. Long-term maintenance and monitoring of containment facility required. Public objection to disposing hazardous material in their "backyard."	5	57	40
6. LOCAL DISPOSAL Removal methods are the same as for Alter-Alternative 3. Sludges would be dewatered and solidified prior to disposal. Disposal would be in a RCRA-design facility built on or adjacent to contaminated areas. Quantity of Material to be Stored: 48,000 yd^3 (Alt. A) 53,000 yd^3 (Alt. B)	3-exceeds standards	Containment effectively removes TCDD from public and environment exposure. No restrictions of future use of wastewater facilities.	Failure of disposal facility could result in contamination of groundwater and flood plain. Suitability of site for permanent disposal facility is uncertain due to location in flood plain and possibly soil conditions. Future acceptance by regulatory agencies of disposing TCDD wastes is uncertain. Public concern about having disposal facility in their "backyard."	5	61 (63)	43 (48)

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Table 2
(continued)

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time, Years[b]	Total Capital Cost[c], $Million	Total Present Worth[c], $Million
7. NONLOCAL DISPOSAL IN RCRA FACILITY Same as above except contaminated material would be hauled to a nonlocal RCRA disposal facility. Quantity of Material to be Stored: 48,000 yd^3 (Alt. A) 53,000 yd^3 (Alt. B)	1-RCRA offsite facility and 3-exceeds standards	Containment effectively removes TCDD from public and environment exposure. No restriction of future use of wastewater facilities.	Currently there is no disposal facility permitted to accept TCDD waste. Future acceptance by regulatory agencies of disposing TCDD wastes is uncertain. Potential for hazardous waste spillage during hauling increases with haul distance.	5	71 (76)	45 (53)

[a]The EPA categories are alternatives which: 1) use a RCRA offsite facility, 2) attain standards, 3) exceed standards, 4) meet CERCLA goals but do not meet standards, and 5) require no action. These categories are further discussed in the "National Oil and Hazardous Substances Contingency Plan" (November 20, 1985, Federal Register).
[b]The implementation time refers to the time from when design of the remedial alternative commences to when the remediation actions are complete--except for ongoing maintenance and monitoring.
[c]When 2 sets of costs are presented for an alternative, the costs without parentheses are for Alternative A (cleaning of sewers in-place) and the costs within parentheses are for Alternative B (removal of sewerline and pipe zone material).
[d]The extent of cleanup of the wastewater facilities assumed in this FS includes removing some soils around the treatment facilities which appear to have TCDD levels of less than 5 ppb. The action level proposed by ATSDR was 1 ppb for this area. However, the assumed increase in cleanup level increases the quantity of material and costs only slightly over that for the cleanup required to conform with ATSDR's recommendations.

Notes: Costs in 1986 dollars.
Discount rate = 10%.

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to range from $1.7 to $97 million, except no cost is associated with the no action alternative. Again, the most costly alternatives were the alternatives requiring incineration. Disposal in the existing wastewater facilities, a sub-RCRA alternative, was the least expensive disposal alternative with an estimated present worth of $40 million.

COST SENSITIVITY ANALYSIS

An analysis was conducted to determine the sensitivity of capital costs to some key variables--the quantity of material to be remediated, incineration and nonlocal disposal fees, and haul distance to nonlocal incineration or disposal. The results are presented in Tables 3 and 4.

Varying the cleanup level had a substantial effect on the costs for remediating the waterways and flood plain. Varying the assumed cleanup level from 2.5 ppb for the waterways and flood plain to 0.25 ppb for the flood plain plus removal of all waterway contaminated sediment increased the capital cost for the removal alternatives by over five, to as much as forty times, depending on the alternative.

By increasing the assumed solids content in the wastewater sludges from 2 percent to 8 percent, the capital costs for the removal alternatives increased from about 80 percent to 160 percent, depending on the alternative.

The capital costs for the incineration alternatives increased by about 90 percent to 130 percent as the incineration costs were varied from $400 to $1,500 per ton. The capital costs for the nonlocal storage alternatives increased by about 30 percent to 40 percent as the fee for disposal at a nonlocal RCRA storage facility was varied from $50 to $300 per cubic yard. The costs for nonlocal incineration increased by 5-10 percent as the haul distance was increased from 100 to 500 miles. The costs for nonlocal disposal increased by 15-20 percent as the haul distance was increased from 100 to 500 miles.

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Table 3
WATERWAYS AND FLOOD PLAIN
SENSITIVITY ANALYSIS

	Capital Cost/Present Worth, $ million						
Variable Factor	No Action	Restrict Access and Monitor Migration	In-Place Containment	Local Incineration	Nonlocal Incineration	Local Disposal	Nonlocal Disposal
Base Case[a]	0	1.6/1.4	4.6/3.8	240/160	220/140	65/49	79/55
Contractor Cost							
Range Incineration: $400-1500/ton Nonlocal Disposal: $50-$300/cy	0[c]	1.6/1.4[c]	4.6/3.8[c]	140-330/90-220	130-300/80-190	65/49[c]	73-100/52-71
Haul Distance to Nonlocal Incineration/ Disposal							
Range 100-500 miles	0[c]	1.6[c]/1.4	4.6[c]/3.8	240[c]/160	220-230/140-150	65/49[c]	66-79/47-55
Level of Cleanup/ Quantity of Material[b]							
0.25 ppb[b]	0[c]	4.8/3.5	86/63	3,200/820	2,900/750	550/370	740/470
2.5 ppb[d]	0[c]	0.89/0.85	2.2/1.9	81/53	73/48	27/20	30/21

[a] The base case was used for developing and evaluating the alternatives. The incineration cost was assumed to be $1,000 per ton; the nonlocal disposal cost $100 per yd^3; the haul distance for nonlocal incineration, 200 miles; the haul distance for nonlocal disposal, 500 miles; the waterways channels sections with TCDD levels greater than or equal to 1 ppb would be remediated, including the banks and adjacent flood plain in these sections.

[b] A cleanup level of 0.25 ppb corresponds to the flood plain. All the contaminated loose bottom sediment in Rocky Branch (9600 ft/4100 yd^3) and Bayou Meto (24,800 ft/53,000 yd^3) which was identified in RI would be removed.

[c] The cost for this alternative is not affected by the variable factor.

[d] This action level was applied to the waterways and flood plain.

Costs are in 1986 dollars.

Table 4
WASTEWATER FACILITIES
SENSITIVITY ANALYSIS

Variable Factor	No Action	Restrict Access, Abandon Facilities, and Monitor Migration	Local Incineration[a]	Nonlocal Incineration[a]	Storage in Wastewater Facilities	Local Disposal[a]	Nonlocal Disposal[a]
	Capital Cost/Present Worth, $ million						
Base Case[b]	0	1.9/1.7	A--120/83 B--140/97	A--110/78 B--130/90	57/40	A--61/43 B--63/48	A--71/45 B--76/53
Contractor Cost							
Range Incineration: $400-$1500/ton; Nonlocal Disposal: $50-$300/cy	0[c]	1.9/1.7[c]	A--80-150/55-87 B--90-180/62-130	A--74-140/52-99 B--83-170/58-120	57/40[c]	A--61/43[c] B--63/48[c]	A--67-88/43-54 B--69-95/48-67
Haul Distance to Nonlocal Incineration/Disposal							
Range 100-500 miles	0[c]	1.9/1.7[c]	A--120/83[c] B--140/97[c]	A--110-120/76-82 B--130-140/89-97	57/40[c]	A--61/43[c] B--63/48[c]	A--62-71/40-45 B--65-76/46-53
Solids Content of Wastewater Sludges							
Range 2%-8% solids	0[c]	1.9/1.7[c]	A--70-170/48-120 B--90-190/62-130	A--61-160/43-110 B--80-180/57-130	41-72/29-51	A--42-80/31-54 B--45-82/33-62	A--46-97/31-58 B--50-100/35-71

[a] Costs given without parantheses are for Alternative A--cleaning of sewers--and Alternative B--removal of sewer line and pipe zone material.

[b] The base case was used for developing and evaluating the alternatives. The incineration cost was assumed to be $1,000 per ton; the nonlocal disposal cost, $100 per yd^3; the haul distance for nonlocal incineration, 200 miles; the haul distance for nonlocal disposal, 500 miles; the solids content of the wastewater sludges, 5 percent.

[c] The cost for this alternative is not affected by the variable factor.

Costs are in 1986 dollars.

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CONTENTS

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TABLES

TABLES (continued)

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Section 1
INTRODUCTION

PURPOSE AND SCOPE OF THIS REPORT

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that the U.S. Environmental Protection Agency (EPA) establish procedures to ensure that the Hazardous Substance Response Trust Fund (commonly known as Superfund) be used as effectively as possible in responding to releases of hazardous substances in the environment. In accordance with CERCLA, the EPA has established a process for discovering releases, evaluating remedies, determining the appropriate extent of response, and ensuring that remedies selected are cost-effective. This process is commonly referred to as the remedial investigation/feasibility study (RI/FS) process, and is outlined in the revised National Contingency Plan (NCP), (U.S. EPA, November 20, 1985).

For every site that is targeted for remedial response action under CERCLA, the NCP requires that a detailed RI/FS be conducted. The RI emphasizes data collection and site characterization. Its purpose is to define the nature and extent of contamination at a site to the extent necessary to evaluate, select, and design a cost-effective remedial action. The FS emphasizes data analysis and decisionmaking; it uses the data from the RI to develop response objectives and alternative remedial responses. These alternatives are then evaluated in terms of their engineering feasibility, public health protection, environmental impacts, and costs.

This feasibility study (FS) provides a wide range of technical and site-specific information for evaluating optional remedial actions at the Vertac offsite locations near Jacksonville, Arkansas, which are contaminated with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). The specific technologies assumed in the remediation alternatives are representative technologies that are presented to make comparative evaluations and cost estimates. In developing alternatives, several assumptions, such as soil stability, soil moisture content, and dewatering capability of sludges, had to be made because of the limited detailed site information.

LEGISLATIVE AUTHORITY

The NCP establishes the guidelines and procedures that will be used to implement the CERCLA Superfund law. The Superfund program recognizes that responses and cleanups of hazardous waste sites must be tailored to the specific needs of each site to mitigate the release of hazardous substances into the environment "which may present an imminent and substantial danger to public health or welfare."

FIGURES

DE/VERTC6/040

REPORT ORGANIZATION

Section 2 of this report provides background information on the history of TCDD-contamination at and near the industrial site now occupied by Vertac, Inc., in Jacksonville, Arkansas. It summarizes the remedial actions taken at the industrial site, and the results of previous studies, including the offsite remedial investigation.

The rest of this report discusses technologies and remedial alternatives for two major contaminated areas--the waterways and the flood plain and wastewater facilities. The remedial technologies are categorized into three areas: management of migration, waste handling, and ultimate waste management. Sections 3 and 4 identify general response actions and screen technologies. Those technologies retained after preliminary screening are assembled into remedial alternatives and developed further in Sections 5 and 6. Section 7 evaluates the remedial alternatives based on technical feasibility, impact on the environment and public health, and conformance with institutional issues. Section 8 presents the results of the cost analyses. Section 9 summarizes the development and analysis of the remedial alternatives.

INFORMATION SOURCES

SITE INFORMATION

Site information was obtained from the Offsite Remedial Investigation, Final Report, (U.S. EPA, December 1, 1985); from Ecology and Environment, Inc. employees who worked on the remedial investigation; and from City of Jacksonville employees.

REMEDIAL ALTERNATIVES

A search was conducted to gather information on potentially viable remedial alternatives for the TCDD-contaminated sites.

Previous EPA reports for TCDD-contaminated sites were reviewed and included the following:

- Draft, Onsite Feasibility Study, Vertac Facility, Jacksonville, Arkansas, U.S. EPA Region VI report, March 1984.

- Love Canal Sewers and Creeks, Remedial Alternatives Evaluation and Risk Assessment, U.S. EPA Region II report, March 28, 1985.

- Feasibility Study of Final Remedial Actions for the Minker/Stout Site, Second Agency Review Draft submitted to U.S. EPA Region VII, February 1986.

- Central Storage Site Report Feasibility Study: Missouri Dioxin Sites, submitted to U.S. EPA Region VII, December 1983.

- "Hazardous Waste Facility Permit Application: Times Beach, Missouri, Interim Central Storage Facility for Dioxin-contaminated Soil and Debris," submitted to U.S. EPA Region VII, April 1984.

- Draft Focused Feasibility Study Report for Romaine Creek, Missouri, submitted to U.S. EPA Region VII, July 1985.

- "Final Draft Report: Onsite Storage Focused Feasibility Study, Bliss and Contiguous Properties Ellisville, Missouri," submitted to U.S. EPA Region VII, February 1986.

Information was solicited from Tony Gardener, U.S. EPA Region VI TCDD Coordinator and Paul des Rosiers, U.S. EPA Department Chairman of the TCDD Disposal Advisory Group.

The DIALOG Information Retrieval Service of DIALOG Information Services, Inc., was used to search literature for information on possible remedial actions for TCDD-contaminated material. Four data bases were used:

- The COMPENDEX data base is a machine-readable version of the Engineering Index and includes abstract information from approximately 3,500 engineering and technical journals published worldwide and selected government reports and books.

- The NTIS data base covers government-sponsored research, development, and engineering, plus analyses prepared by federal agencies, their contractors, or their grantees.

- The SCISEARCH data base is a multidisciplinary index to science and technical literature prepared by the Institute for Scientific Information. Information from approximately 2,600 major scientific and technical journals published worldwide are reviewed.

- The MAGAZINE INDEX data base has a broad coverage of over 435 general interest magazines.

COST SOURCES

The sources used in developing the costs are listed in Section 8--"Cost Analysis."

USE OF THIS REPORT

This report, in keeping with EPA and NCP guidelines, does not contain recommendations for specific remedial activities or a combination of activities. The decisionmaking authority is vested in the EPA, which reaches a decision only after receiving input from the public. The benefits, adverse impacts, and costs of each alternative must be weighed in arriving at the final remedial measures. This report attempts to provide the decisionmakers with that information.

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Section 2
BACKGROUND

SITE HISTORY

This section briefly summarizes past events concerning the Vertac onsite and offsite TCDD contamination. The information presented below was obtained from various sources listed in the bibliography. The more important sources were the Arkansas Department of Pollution Control and Ecology (May 1983); CH2M HILL/Ecology and Environment (April 8, 1984); the City of Jacksonville, Arkansas (June 1971); Cochran (1983); Ecology and Environment (August 3, 1984); and the Draft, Onsite Feasibility Study, Vertac Facility, Jacksonville, Arkansas (U.S. EPA, March 1984).

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PLANTSITE

The Vertac plantsite, located in Jacksonville, Arkansas, just north of Little Rock (see Figures 2-1 and 2-2), was called the Arkansas Ordnance Plant during World War II. The ordnance plant was purchased in 1948 by the Reasor-Hill Company, which began to manufacture pesticides at the site, including (2,4,5-trichlorophenoxy) acetic acid--2,4,5-T. A by-product of 2,4,5-T production was TCDD.

In 1961, Reasor-Hill sold the plant to Hercules Powder Company (later Hercules, Inc.) which continued pesticide production until 1971. Manufacturing during this period produced phenoxy herbicides. In particular, Hercules made large quantities of "Agent Orange," which is a mixture of 2,4,5-T and (2,4-dichlorophenoxy) acetic acid--2,4-D. Hercules also produced as separate herbicidal products 2,4,5-T, 2,4-D, and 2-(2,4,5-trichlorohenoxy) propionic acid--2,4,5-TP.

In 1963, Hercules began extracting most of the dioxins from its products. The process produced solid and liquid wastes that were contaminated with TCDD. For many years, the liquid wastes were channeled through an equalization basin that was used primarily for sedimentation and to some degree for pH equalization. At the outflow end, the pH was adjusted to near neutral levels prior to discharge, via an outfall line, into Jacksonville's sewage treatment system. The solid wastes were buried onsite, mainly in two landfill areas: a south area and a north area.

A noncontact cooling water pond was constructed on the west leg of Rocky Branch, a small watercourse on the plant property. Although the cooling water pond was to receive only uncontaminated water, its sediments became contaminated. The likely sources of contamination were surface runoff from the area around the process facilities and the formerly open north landfill area,

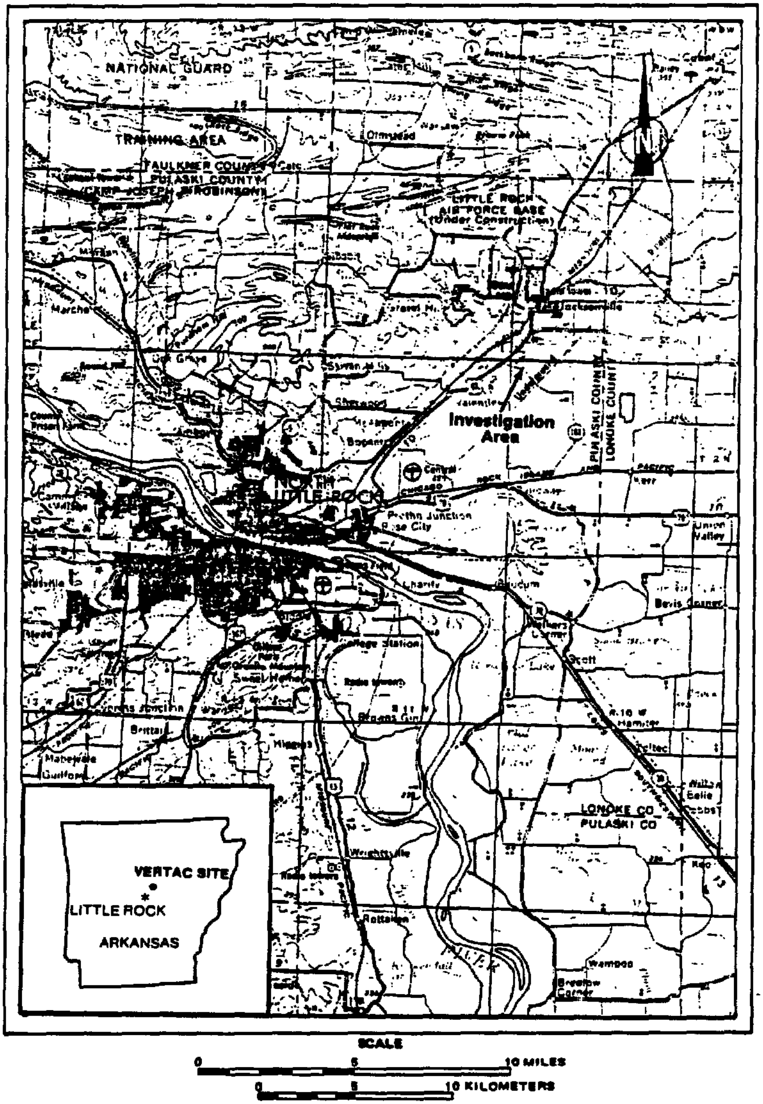

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Figure 2-1
Site Location Map

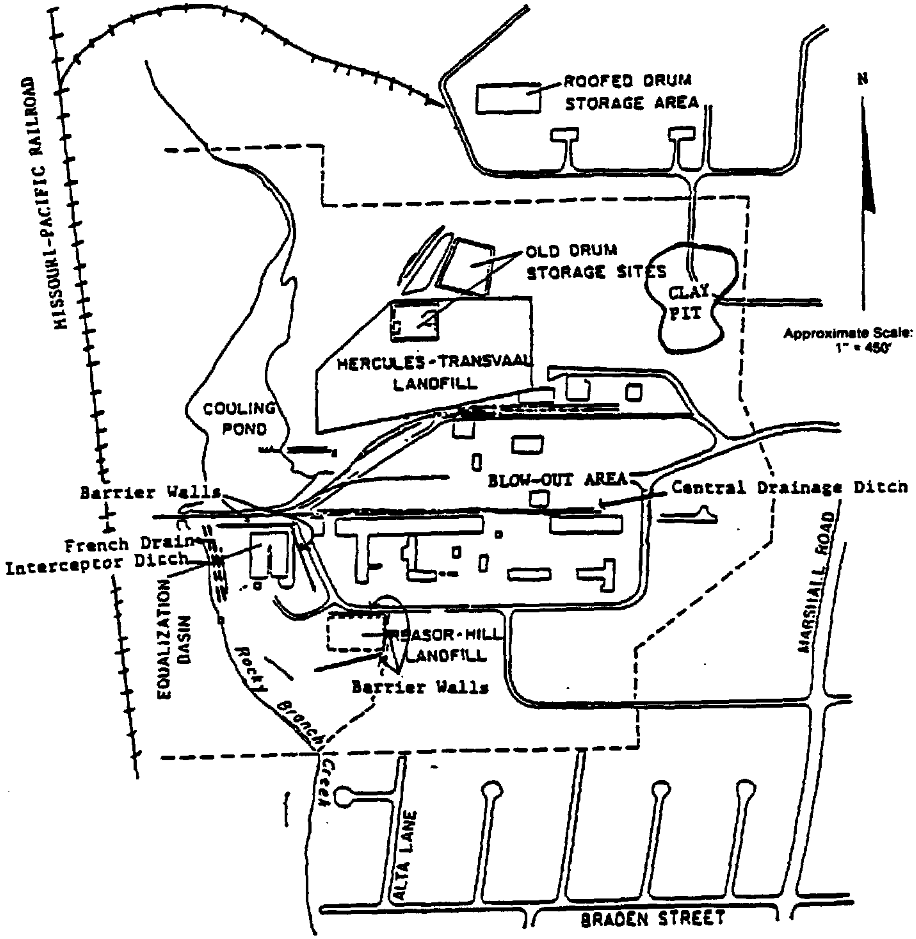

Figure 2-2
Vertac Plant Site

leachate from the buried wastes, and a main surface drainageway on the property.

From 1971 to 1976, Transvaal leased the site from Hercules. In 1976, Transvaal was reorganized into Vertac, Inc., which still operates the plant. Throughout the Transvaal-Vertac period, the plant has continued to manufacture 2,4,5-T, 2,4-D, and 2,4,5-TP. In March 1979, Vertac suspended production of these substances; however, production of 2,4-D was later resumed.

Attention was first focused on the Vertac plant after the National Dioxin Survey in 1978. The EPA sampled production wastes at the facility, and concentrations as high as 40 parts per million (ppm) of TCDD were found in the waste sludges. Lower concentrations were found in materials relating to other steps of the manufacturing processes. As a result of these findings, Region VI EPA and the Arkansas Department of Pollution Control and Ecology (ADPC&E) began investigating the site. The state investigation showed TCDD contamination in wildlife and fish as far as 50 miles downstream from the plant. Samples of the leachate were found to contain TCDD, various pesticides (particularly 2,4,5-T and 2,4-D) and trichlorophenols. High levels of TCDD contamination were found in the sediments of the equalization basin. In addition, the noncontact cooling water was found to be contaminated with phenols, chlorobenzenes, and phenoxy herbicides. TCDD was also found in the cooling pond sediments.

Pursuant to a 1980 Consent Decree, thousands of drums full of pesticide wastes were recontainerized and placed in storage; a clay barrier wall and a French drain were constructed at the south burial site; both the south and the north burial sites were covered and capped; and the equalization basin was drained, its sediments were solidified, and the basin was filled and capped. A detailed chronology of the remedial actions taken by Vertac is contained in the Summary of Technical Data of the Sampling of Sediment and Fish in Bayou Meto and Lake DuPree (ADPC&E, 1983).

In an onsite inventory in February 1982, 2,747 drums of 2,4,5-T and 9,472 drums of 2,4-D still bottom (bottom accumulation from the manufacturing process) were counted. The 2,4-D inventory now exceeds 22,000 drums and is growing at a rate of approximately 300 drums per month. In July 1982, Vertac began a process to recover 2,4-D waste. However, waste recovery has been discontinued, and Vertac is currently considering waste disposal by incineration.

The EPA did not feel that the remedy being implemented at the site provided adequate protection for human health and the environment. When negotiations failed to resolve differences between the EPA and Vertac, Vertac asked for court

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intervention. In the summer of 1984, the court ruled in Vertac's favor. To prevent migration of buried wastes at the plant, the court decision mandated constructing slurry walls and French drain systems, extending existing clay caps, upgrading protective vegetation at the burial sites, and draining the cooling water pond and removing its contaminated sediments. Vertac completed most of the work in the fall of 1985. Some minor work, such as reseeding and installing a few sump pumps, has yet to be done.

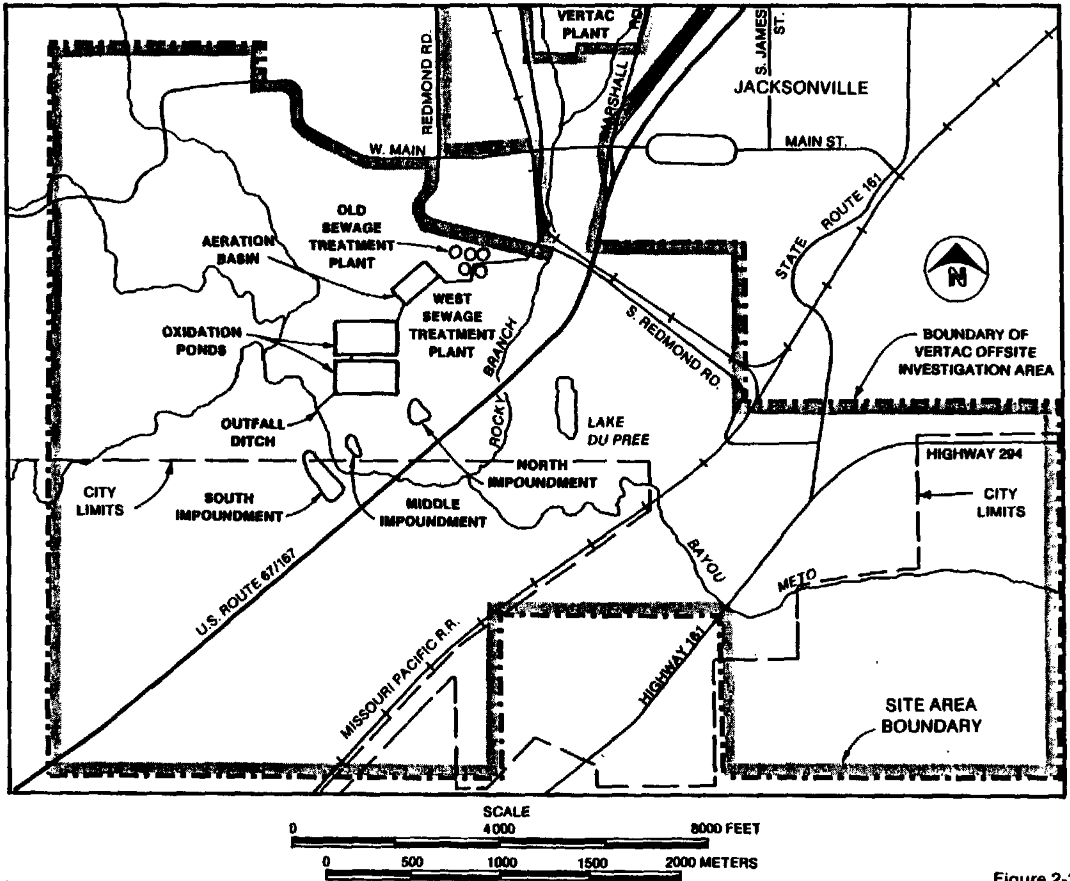
OFFSITE INVESTIGATION AREA

The offsite investigation area is shown in Figures 2-3, 2-4, 2-5, and 2-6. Surface runoff from the Vertac plant flows into Rocky Branch, a small watercourse that flows into Bayou Meto, which is a larger watercourse that flows into the Arkansas River. The pesticide plant and adjacent residential, commercial, and industrial areas areas are served by the Jacksonville sanitary sewer system, which used to discharge into the Old Sewage Treatment Plant (now abandoned) and now discharges into the West Wastewater Treatment Plant (WWTP). The Old Sewage Treatment Plant discharged into Rocky Branch, and now the WWTP effluent discharges into Bayou Meto. Rocky Branch and Bayou Meto flood frequently, possibly carrying contaminants from the streams into the flood plain and several water impoundments in the flood plain. Bayou Meto waters are also used for irrigation of nearby farmlands.

Escape of TCDD-contaminants to offsite areas likely dates back to 1948, when the first pesticide production started, and became more substantial after production of Agent Orange began in the 1960's.

The Arkansas Ordnance Plant sewer lines had been constructed in 1941 and were in operation at the time Reasor-Hill purchased the plant. During the Reasor-Hill period, pesticide wastes were likely discharged into the sewer lines and into Rocky Branch.

The Old Sewage Treatment Plant was in operation until 1961. Although arrangements to treat pesticide wastes were only formalized in 1961, prior operational problems in the Old Sewage Treatment Plant were likely caused by discharges from the pesticide plant. A process waste outfall line was constructed in 1961 to convey plant wastes to the Rocky Branch Interceptor, the main line of the area's sewage collection system. Pretreatment of the process waste consisted only of pH neutralization and stabilization. However, other sewer lines had existed between the Arkansas Ordnance Plant and the Rocky Branch Interceptor, and some plant wastes may have entered the sewer system through these lines not only before, but also after the construction of the process waste outfall. A manhole on one of these lines, manhole 71, was tested in



Source: Offsite Remedial Investigation
Final Report (U.S. EPA, December 1, 1985)

Note: In the future, the extent of remediation may extend beyond the boundaries shown for the Vertac offsite investigation area.

Figure 2-3
Offsite Investigation Area

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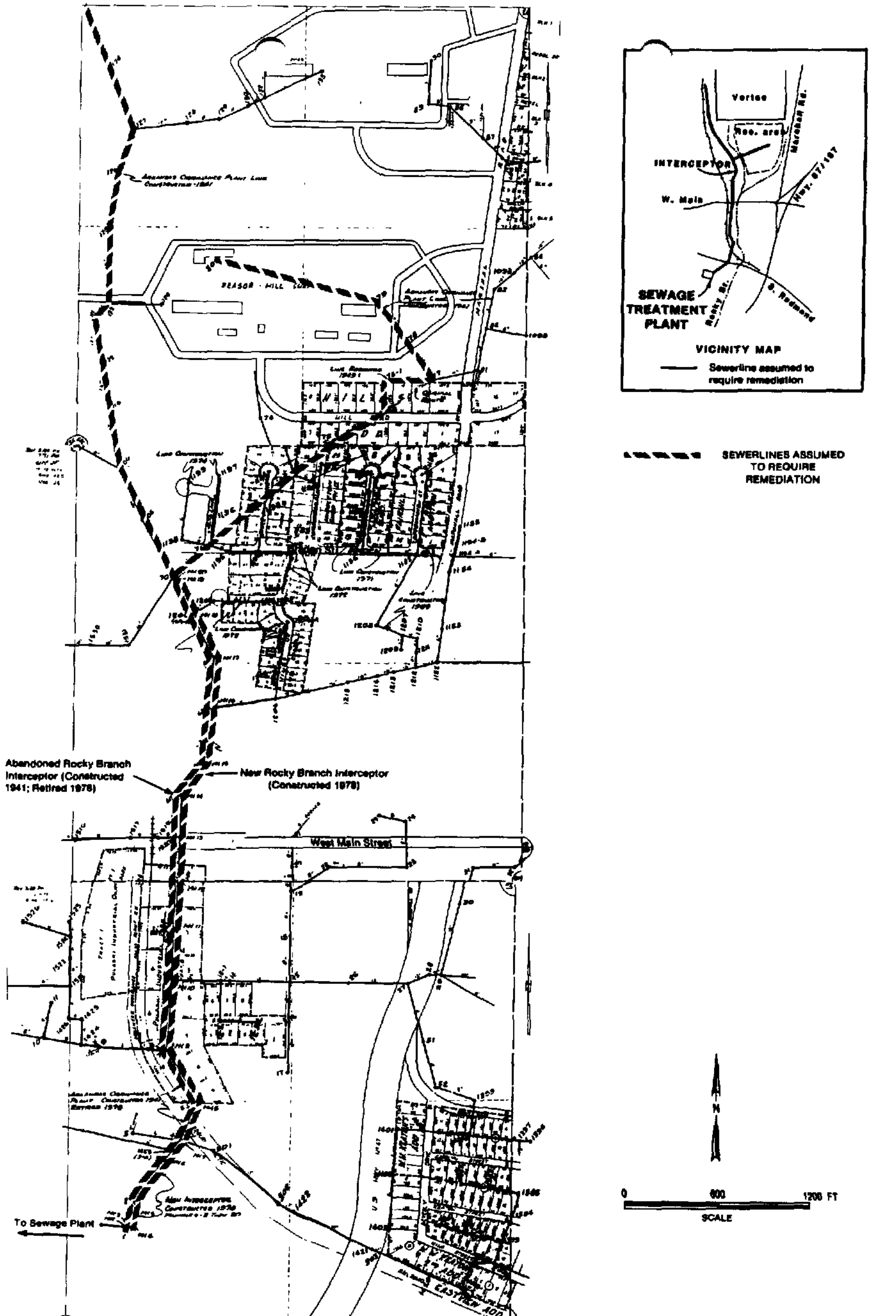

Figure 2-4
Wastewater Collection System

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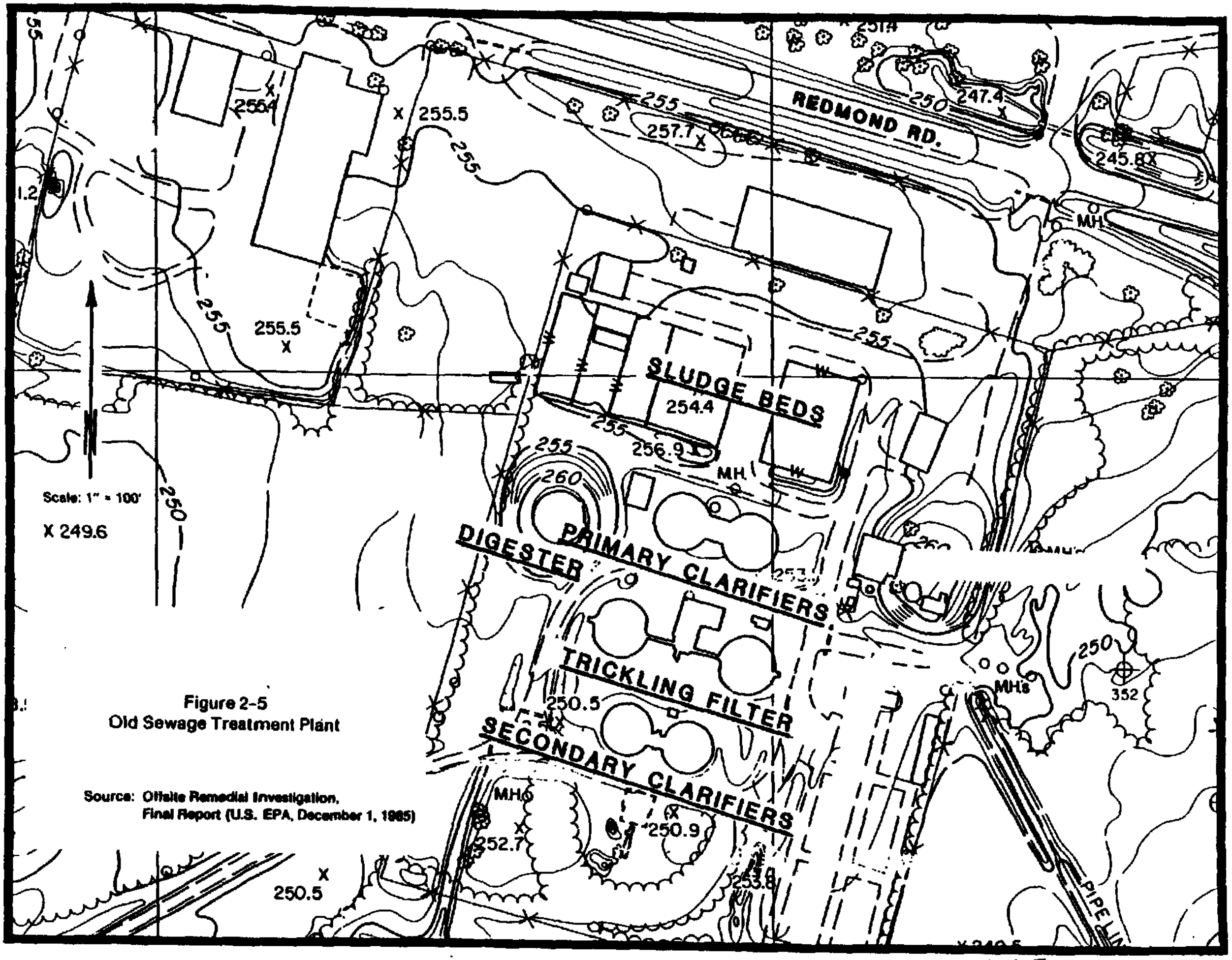

Figure 2-5
Old Sewage Treatment Plant

Source: Offsite Remedial Investigation,
Final Report (U.S. EPA, December 1, 1985)

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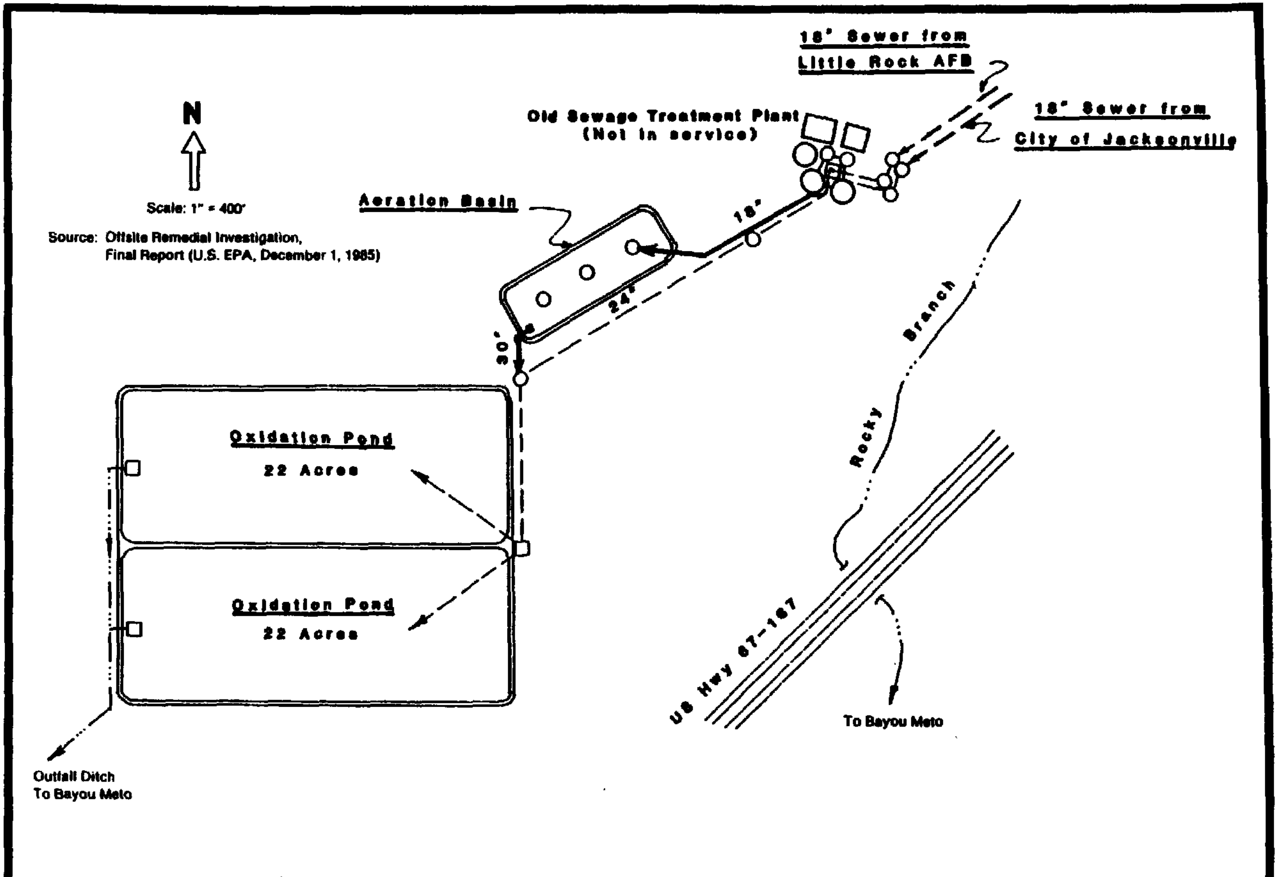

Figure 2-6
West Sewage Treatment Plant

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1979, when it showed 0.159 parts per billion (ppb) TCDD, and again in 1981, when it showed 10.9 ppb TCDD.

Prior to the arrangements for treating the plant waste, commercial fishermen and residents along Bayou Meto frequently complained of odors in the bayou, odd odors and taste in fish, and also occasional fish kills. After the Old Sewage Treatment Plant began accepting the plant waste for treatment, the complaints continued, although the number was reduced. As a result of the complaints, the Arkansas Pollution Control Commission conducted a special survey in the upper Bayou Meto basin in the first half of 1967. The study linked the problem with high 5-day biochemical oxygen demand (BOD_5) loading and ineffective phenolics removal in the sewage treatment system.

The Arkansas Health Department quarantined Rocky Branch in the late 1970's from where it flows through the Vertac property to its confluence with Bayou Meto and quarantined Bayou Meto from Jacksonville to where it flows into the Arkansas River. Commercial fisheries in the bayou have been banned by the Health Department since 1979 because of TCDD contamination.

The data collected by ADPC&E and the EPA previous to the offsite remedial investigation (conducted by Ecology Environment, Inc. between the fall of 1983 and the spring of 1985) covered the period between June 1975 and May 1983 and gradually identified the magnitude of the potential offsite contamination problem. The following is an overview of the soil/sediment sampling prior to the RI.

The first samples were collected from June 1975 to August 1975 in the residential area south of the Vertac site. Among these samples, 4.2 ppb TCDD were found in the rose garden at 2113 Braden Street, and 2.6 ppb was found on Lot 21 on West Lane. All other samples contained less than 1 ppb TCDD.

In September 1979, the first sediment samples were collected in Rocky Branch and Bayou Meto at some of the bridge crossings. Low concentrations of TCDD were found at most locations, except in Rocky Branch at the Highway 67/167 crossing, where 2.5 ppb were found, and in Bayou Meto at the Highway 161 crossing, where 1.6 ppb were found. A few other locations were sampled in the residential area south of the Vertac plantsite. At the WWTP, one sample was taken from the north oxidation pond, where 8.37 ppb were found, and one from the south pond, where 7.75 ppb were found. The manhole at Braden and Alta Lanes was sampled and 0.159 ppb was found, and an unidentified location of the "Sewerline, Vertac to Jacksonville Wastewater Treatment Plant" had 1.13 ppb TCDD.

In May 1980, three soil samples were taken in DuPree Park. One sump at the "West Side Shoreline of Lake DuPree" contained 0.228 ppb TCDD.

In March 1981, TCDD samplings were repeated at some of the previously sampled points at bridge crossings of Rocky Branch and Bayou Meto. Some new points were added at these locations. All samples contained concentrations of less than 1 ppb TCDD. The sampling was also extended to the east and west legs of Rocky Branch in the residential area immediately south of Vertac. In the west leg, 0.27 ppb was found. In the east leg, 0.535 ppb was found. In a drainage ditch adjacent to the Vertac plant site at Marshall Road, 0.610 ppb was found. A composite sample collected from the north and south oxidation ponds at the WWTP contained 3.4 ppb TCDD. The manhole at Braden and Alta Lanes was resampled and 10.9 ppb TCDD were found. Several surface locations in the residential area were also sampled. None of the samples contained measurable concentrations of TCDD. The locations included are in the rose garden at 2113 Braden Lane, which had contained 2.6 ppb TCDD in 1979.

In December 1981, some locations of Bayou Meto were resampled. Less than 1 ppb TCDD was found at all points. In November 1982, another sampling was performed in the residential area. No measurable TCDD concentrations were found.

In May 1983, the EPA performed extensive sampling of the residential area near the plant. The samples were not analyzed for TCDD, however. Priority pollutants were analyzed for 2,4-D, 2,4,5-T, 2,4,5-TP, total chlorinated phenols, and total chlorinated benzenes. All but one location tested below the quantification limit. A composite sample from three locations in the front yard of 625 Carpenter Lane contained 2 ppb 2,4-D, and 1 ppb 2,4,5-T.

Results of the samplings by the EPA and the ADPC&E through 1982 were compiled in the 1983 ADPC&E report.

The only study in the investigation area not performed by the EPA or the ADPC&E was performed by Environmental and Toxicological Consultants, Inc. (ETC), on commission from Vertac. The ETC study was limited to three areas off the plantsite: Rocky Branch, Bayou Meto, and Lake DuPree, a lake in a recreation area south of the site. The consideration of Rocky Branch and Bayou Meto was based on previous data gathered by the EPA or the ADPC&E, and concluded that TCDD in the watercourses was decreasing. New data were generated for Lake DuPree. The ETC report indicated that Lake DuPree sediments contained up to 0.192 ppb TCDD.

Most of the data from samplings prior to the RI lack quality due to inadequate quality control in the field and in the laboratories and lack of accurate records concerning sampling methods and sampling locations. Due to these limitations, comparing sampling results or assessing historical trends is virtually impossible.

INTERPRETATION OF SITE

Remedial actions that occur within contaminated areas of a National Priority List (NPL) site are considered onsite actions. While onsite actions taken under CERCLA must meet the intent of the Resource Conservation and Recovery Act (RCRA), they do not require RCRA permits. Therefore, the onsite remedial alternatives for this Vertac offsite FS would not require RCRA permits.

PREVIOUS STUDIES AND REPORTS

Since the Vertac plant was identified as a potentially hazardous site in 1978, a great deal of data have been collected. These data have formed the basis for several reports covering such areas as onsite and offsite contamination, environmental conditions, groundwater, and geology.

The data in these reports will not be repeated here. The following list identifies these major documents:

1. Aerial reconnaissance of Vertac, Inc., Jacksonville, Arkansas; U.S. EPA, Las Vegas, November-May 1979.

   This report used a series of historical photographs to document changes that have occurred at the Vertac site and the locations of spills and contamination.

2. "Final Report for Environmental Assessment Study, Vertac Chemical Corp. Site, Jacksonville, Arkansas;" Developers International Service Corp., Memphis, Tennessee, October 1982.

   This report was developed to satisfy the requirements of the 1982 Consent Decree and contains an assessment of onsite conditions.

3. "Supplemental Report for Environmental Assessment Study, Vertac Chemical Corp. Site, Jacksonville, Arkansas;" Developer International Service Corp., December 1982.

   In this report, DISC responds to questions raised by the EPA as a result of the review of the previous report, the results of recent testing is included, and proposed remedial measures are briefly outlined.

4. "Technical Report for Rocky Branch, Bayou Meto, and Lake DuPree;" Environmental Toxicological Consultants, March 1983.

This report summarizes offsite data that have been collected since 1979 for the three water bodies. A final report that includes recent sampling data was published in late 1983 (undated).

5. "Summary of Technical Data, Jacksonville, Arkansas;" Arkansas Department of Pollution Control and Ecology, No date (mid-1983).

   This report is a compilation of all data collected in conjunction with the Vertac plant. Included are virtually all sampling data and excerpts of the reports listed above.

6. "Proposed Onsite Environmental Remediation--Remediation Construction Plan Package for Vertac Corporation Plant Site, Jacksonville, Arkansas," D'Appolonia, January 1984.

7. Draft, Onsite Feasibility Study, Vertac Facility, Jacksonville, Arkansas; Prepared by CH2M HILL, Inc., for the U.S. EPA, Revised March 30, 1984.

8. Offsite Remedial Investigation, Final Report; prepared by CH2M HILL, Inc., and Ecology and Environment, Inc., for the U.S. EPA, December 1, 1985.

   The results of the investigation are summarized below.

9. Vertac Offsite Endangerment Assessment, Draft Report; prepared by CH2M HILL for U.S. EPA Region VI, April 1986.

   The results of this assessment are summarized below.

REMEDIAL INVESTIGATION

The RI for the offsite area adjacent to the Vertac Chemical Corporation plant was performed between the fall 1983 and spring 1985. The purpose of the RI was to discover if TCDD had migrated off the plant site, and if so, to identify contaminated areas.

The results of previous studies suggested that contamination in the investigation area would be concentrated in the sewage collection and treatment system and along the nearby watercourses. TCDD is known to have an extremely low water solubility and a strong tendency to bind to soils or sediments. Therefore, the RI field work on three occasions consisted of soil and sediment sampling and analysis, as well as a series of special investigations, including: a flood plain delineation study to assist in estimating the amount of soil that could be contaminated as a result of floods, a sewer lamping to assist in estimating the amount of sediment in the sewage collection systems, a sonar survey to assist in calculating the amount of sediment in the impoundments, and an aquatic biota survey.

Groundwater sampling and analysis was not included in the study plan. The decision was based on the low water solubility of TCDD as well as the results of a limited testing of deep wells in the early stages of the RI, which showed no measurable TCDD in groundwater. Surface water was also not tested. Soil and sediment sampling was considered a more effective use of RI funds.

Previous studies indicated contaminants other than TCDD in the investigation area, such as 2,4-D, 2,4,5-T, 2,4,5-TP, chlorinated benzenes, and chlorinated phenols. The RI concentrated on TCDD because it is considered the most hazardous contaminant in the area, and remediation for TCDD would also remediate most other contamination problems. Limited exploratory testing was performed for the other compounds, but the results were inadequate to precisely determine the extent and amount of such contamination.

Elevated levels of chlorobenzenes, chlorophenols, and other contaminants were found principally in the sewage system, to a much lesser degree at surface locations near the Vertac plant, and sporadically at locations distant from the plant. Findings on these other contaminants appear consistent with known differences in persistency between these substances and TCDD. These contaminants degrade more readily than TCDD. In the areas where contaminants other than TCDD were found, TCDD was also found at concentrations that were of greater concern than those of the other contaminants.

A total of 324 soil and sediment samples were collected during the RI and tested for TCDD. Seventy-four were taken in December 1983, of which 40 contained measured quantities of TCDD; 21 were taken in June 1984, of which 1 contained a measured quantity; and 225 were taken in August 1984, of which 79 contained measured quantities.

In Rocky Branch, concentrations in excess of 2 ppb were found in samples upstream of West Main Street and at Highway 67/167. TCDD concentrations were found to decrease with distance from the Vertac plantsite.

In Bayou Meto, a wide range of concentrations was found. The most notable findings were the sharp rise in concentrations below the WWTP outfall into the bayou, and the slight effect from Rocky Branch entering the bayou. Only a slight increase was found in samples downstream versus upstream of the mouth. Most contamination appeared to be trapped in sediment between the outfall and Highway 161.

No samples from Lake DuPree or the north, middle, or south unnamed impoundments (Figure 2-3) showed TCDD concentrations as high as 1 ppb.

In the flood plain, the data indicate possible low-level contamination. While some contaminated deposit areas were located, considering the vast expanse of the flood plain and the small number of samples collected, the existence of other deposit areas remains a possibility. However, the data indicate that the majority of the flood plain has only low concentrations of TCDD, if any.

All components of the sewage collection and treatment system, including the old and west sewage treatment systems (Figures 2-5 and 2-6), appear to be contaminated with TCDD. The average TCDD concentration of 26 samples in the sewage collection system, excluding the three highest samples, was 7.93 ppb. Including the three highest, it was 21.5 ppb. The highest concentration was greater than 200 ppb. TCDD concentrations in the aeration basin averaged 15.7 ppb. In the north oxidation pond, the average of samples containing more than 1 ppb was 3.65 ppb. In the south oxidation pond, it was 4.01 ppb.

The total estimated volume of sediment and sludge in the WWTP aeration basin and oxidation ponds is 214,000 cubic yards (yd^3). The total estimated volume in the Old Sewage Treatment Plant facilities is 500 yd^3. The total estimated volume in the sewage collection system is 47 yd^3.

The RI was successfully completed as intended by the study plan. However, sewer lamping showed deteriorated and broken sewer lines and indicated the possibility of exfiltration of contaminants into the groundwater system. Furthermore, along the watercourses and in the flood plain, most sample results were below the lower quantification limit of 1 ppb specified in the standard Contract Lab Program, including many measured concentrations.

The RI data also indicated a correlation of TCDD distribution and scour and deposition activity in the flood plain.

ENDANGERMENT ASSESSMENT

The endangerment assessment (EA) for this site is presented under a separate cover (U.S. EPA, June 1986). The objective of the EA is to evaluate the potential health and environmental effects if no remedial action is taken at the offsite area adjacent to the Vertac Chemical Corporation, Jacksonville, Arkansas. The EA defines the current or potential health and environmental effects if no remedial action is taken at the offsite area adjacent to the Vertac Chemical Corporation, Jacksonville, Arkansas. It defines the current or potential future problems attributable to contaminants, primarily TCDD, at the site.

The EA includes a discussion of the available data and how it is used. Soil, sediment, and fish were sampled and analyzed for TCDD. In some cases, chlorophenoxy herbicides, chlorinated benzenes, and chlorinated phenols were analyzed. Historical data for the site were also considered to identify contamination trends. Concentrations of compounds identified in soils and sediments were compared to background concentrations in the investigation area exceeded expected or normal concentrations for the area.

A discussion of the potential for migration of TCDD from the sewer system, Rocky Branch, and Bayou Meto was included. It concludes that TCDD has the potential to migrate out of the sewage treatment plant, will adsorb onto soils and sediments and can be transported in the creek beds and flood plains.

Potential exposure pathways to contaminated media include direct dermal contact or ingestion of sediments or soils originating from the sewer system, Rocky Branch, Bayou Meto, or the flood plains of Rocky Branch and Bayou Meto; inhalation of volatilized organics, if any, from contaminants in the sewer system, creek, or flood plain sediments or soils, ingestion of fish and other aquatic organisms from Rocky Branch or Bayou Meto, and ingestion of agricultural products that have been grown in contaminated soils.

From the estimate of intakes, and considering various exposure scenarios, risks were quantified. The scenario of residential use of the flood plain presents the highest estimated risk for ingestion of TCDD-contaminated soils. Risk for the various scenarios ranged from an increase in cancer incidence of one to 10,000 per 10 million people exposed.

ACTION LEVEL

The agency for Toxic Substances and Disease Registry (ATSDR) reviewed data for the Vertac offsites. The ATSDR report is included in the appendix of the Endangerment Assessment, U.S. EPA, June 1986. Based on the ATSDR recommendations for TCDD remediation at the site, the following action levels were assumed for the various contaminated areas:

- Wastewater Collection System. The sewer lines that were indicated in the RI to have TCDD concentrations equal to or greater than 1 ppb would be remediated. This action level was chosen because the contaminants in the sewer line could migrate downstream and contaminate the wastewater treatment facilities, Bayou Meto, and nearby flood plains.

- Old Sewage Treatment Plant. The TCDD-contaminated sludges, wastes, soils, and sediments in the abandoned facilities would be remediated. The surface soils around the abandoned sewage treatment facilities would be remediated so that an action level of 1 ppb TCDD is not exceeded. The ATSDR recommended, however, an action level of 5 to 7 ppb TCDD for soils in and around the abandoned sewage treatment facilities if the following conditions were imposed: (1) the site was not developed for agricultural or residential use, (2) the use and activities of the site must not become associated with the production, preparation, handling, consumption, or storage of food, other consumable items, or food packaging materials, and (3) the site soils must be protected from erosion that would uncover or transport TCDD that could cause unacceptable human exposure at a future date. Therefore, the assumed level of remediation of the old sewage treatment plant area is greater than recommended by ATSDR. However, including areas with TCDD levels of 1 to 5 ppb has little impact on the total quantities and costs for the remedial actions proposed for the wastewater facilities.

- West Wastewater Treatment Plant. The aeration pond, oxidation basins, outfall ditch, and the peripheral land that has TCDD levels exceeding 5 ppb TCDD and that would be zoned for manufacturing would be remediated.

- Rocky Branch and Bayou Meto. An action level of 1 ppb TCDD would apply to the sediments and soil in and immediately adjacent to the Rocky Branch and Bayou Meto channels.

- Flood Plain--Residential and Agricultural. A 1-ppb-TCDD action level would be adopted for residential and agricultural areas.

- Flood Plain--Nonresidential and Nonagricultural. Nonresidential and nonagricultural areas in the flood plain (such as woodlands, industrial, and commercial areas) that are not subject to erosion and transport processes would have an action level of 5 ppb TCDD. If the areas are subject to erosion and transport processes then the action level would be 1 ppb. (The flood plain is defined not to be subject to erosion and transport processes if the area has sufficient ground cover to inhibit erosion.

VOLUMES OF CONTAMINATED MATERIALS

Using the previously identified action levels and information from the RI and the RI team, the volumes of contaminated material assumed to be remediated were estimated.

The amount and location of offsite contaminated material varies with time. The contaminated volume estimates given in the RI for the Rocky Branch, Bayou Meto, and the flood plain were based on the August 1984 sampling data. Table 2-1 lists the estimated quantities given in the RI report and the assumed quantities for this report. Figure 2-7 indicates the FS-assumed waterway sections requiring remediation. The land uses were determined from aerial photographs. Zoning changes may be required in some areas to conform with the assumed land uses. The amount of contaminated material at a given level could be better defined with additional testing, such as fine-grid sampling that was recommended by ATSDR, prior to implementing a remedial action. The flood plain and waterways could also be modelled to estimate sediment desposition areas.

The RI estimated volumes and the FS-assumed volumes are approximately in agreement with the following exceptions:

- <u>West Sewage Treatment Plant--Outfall Ditch</u>. Although the RI did not find TCDD levels greater than 1 ppb in the outfall ditch, the outfall ditch was assumed to require remediation, since TCDD levels in the oxidation ponds and in the Bayou Meto downstream from the outfall ditch exceeded 1 ppb.

- <u>Old Sewage Treatment Plant</u>. The FS-assumed volume of contaminated material was based on conversations with the RI team; dimensions of existing basins, sludge drying beds, and outfall ditch (known or assumed); and assumptions of the quantity of contaminated material in each of these facilities/ areas.

- <u>Rocky Branch, Bayou Meto, and Flood Plain</u>. The RI estimated the total amount of loose bottom sediments in the channels. In addition to this material, the FS assumed that bank and near-stream material would require remediation.

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Table 2-1
VOLUMES OF TCDD-CONTAMINATED MATERIAL ASSUMED TO BE REMEDIATED

Contamination Source	RI Estimated Volume	FS Assumed Volume	Comments on FS Assumed Volume
West Sewage Treatment Plant	214,000 yd^3 of sediment	216,000 yd^3 of 5 percent sludge	Assumed RI-reported sediment was 5-percent sludge.
	180,000 yd^3 of wastewater	182,000 yd^3 of wastewater with 1 percent solids	Assumed RI-reported wastewater had 1-percent solids.
	ND	260 yd^3 of sediment in outfall ditch	
Old Sewage Treatment Plant	500 yd^3	1,500 yd^3 of sediment and water in basins	Quantities based on dimensions of facilities and description of materials contained in basins.
		914 yd^3 of soil/sediment in sludge drying beds and outfall ditch	
Sewage Collection System	47 yd^3	46 yd^3	Included an allowance for vegetation in sewers Only the sewers identified with TCDD levels greater than 1 ppb were assumed to be remediated
Rocky Branch			Allowances for overexcavation and debris in the channel were added to the FS-assumed volumes. The assumed volume of contaminated bank material was based on assuming an average stream cross section and that the average depth of contaminated material is 1 foot.
In-stream sediments	1,900 yd^3	1,900 yd^3	
Bank sediments and soils	ND	3,800 yd^3	
Bayou Meto			Allowances for overexcavation and debris in the channel were added to the FS-assumed volumes. (Allowances not included in numbers presented in this table.) The assumed volume of contaminated material was based on assuming an average stream cross section and that the average depth of contaminated material is 1 foot.
In-stream sediments	10,300 yd^3	10,300 yd^3	
Bank sediments and soils	ND	7,500 yd^3	

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Table 2-1
(continued)

Contamination Source	RI Estimated Volume	FS Assumed Volume	Comments on FS Assumed Volume
Flood plain	See Figure 2-8	13,700 yd^3 of near-stream soil along Rocky Branch 23,900 yd^3 of near-stream soil along Bayou Meto	The assumed volume of contaminated near-stream material was based on an average 50-foot-wide contaminated area along each side of the stream sections with assumed TCDD levels greater than or equal to 1 ppb. The assumed average depth of contamination was 1 foot.

Notes: Volumes given are estimates of in-place volumes of contaminated material.

ND = Not Determined

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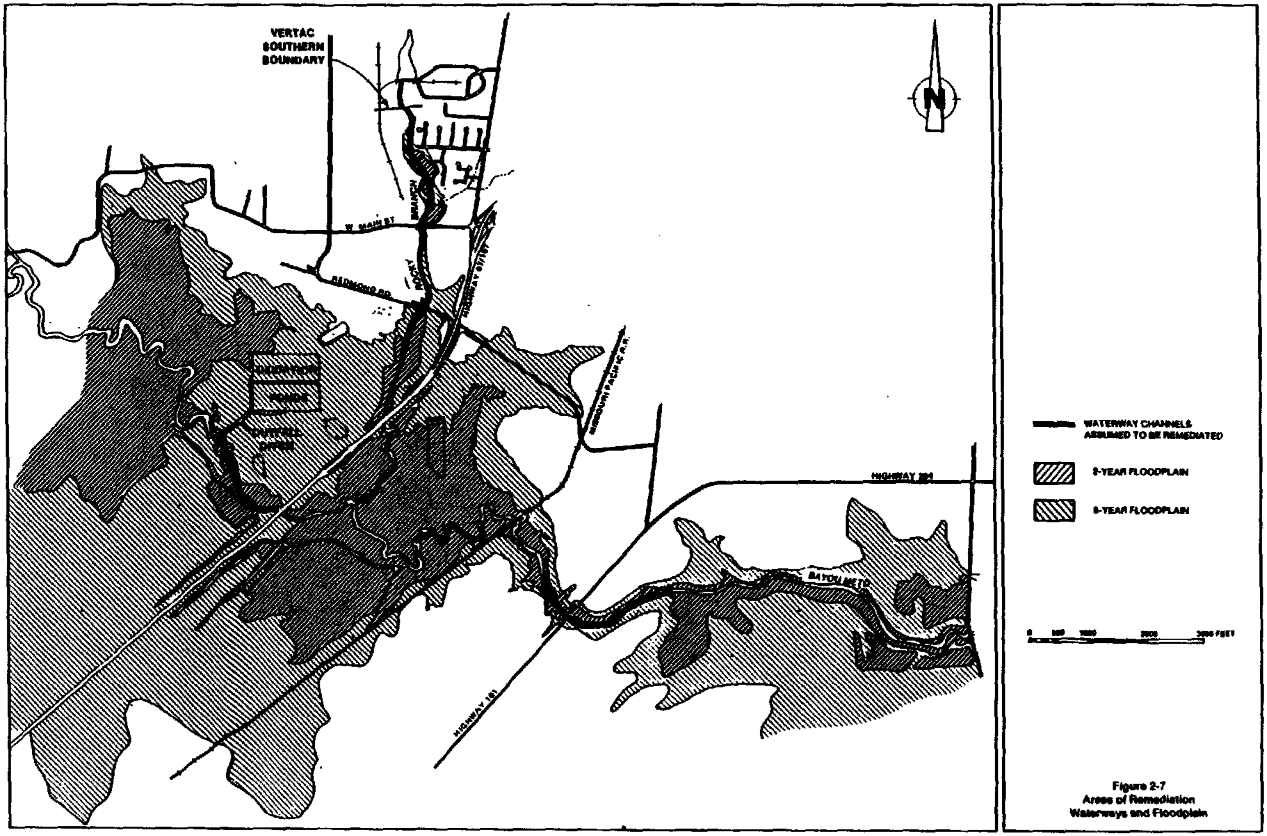
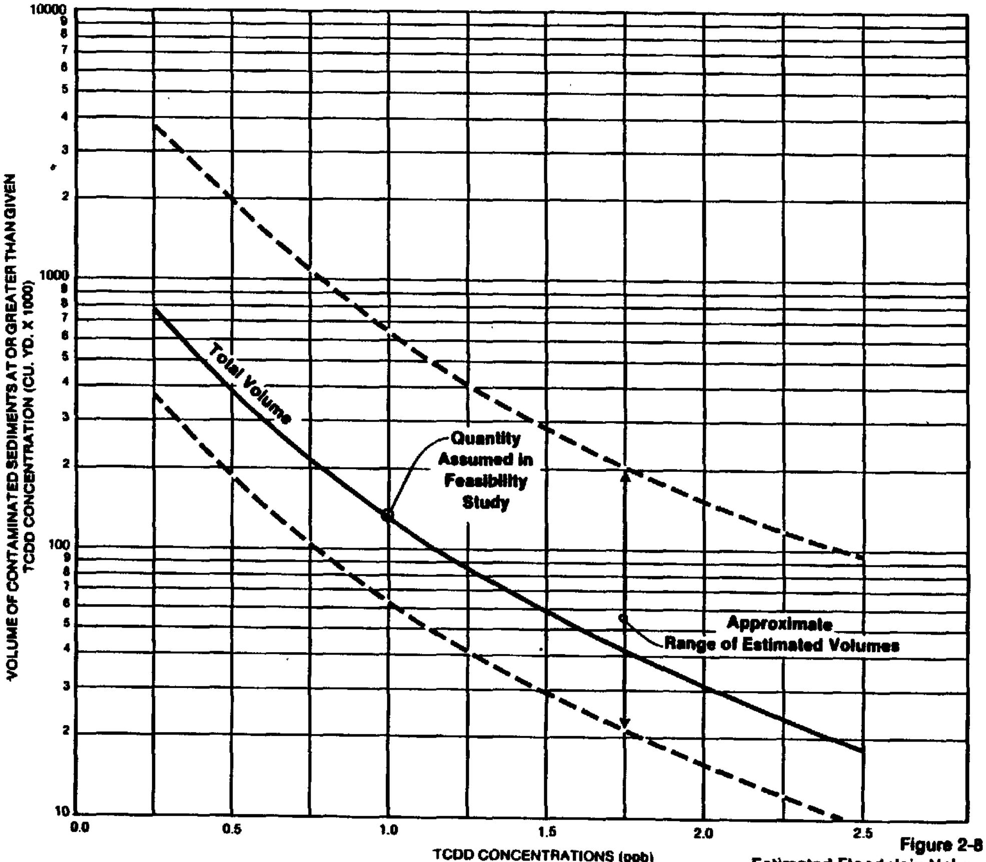


Figure 2-7
Areas of Remediation
Waterways and Floodplain



Source: U.S. EPA (December 1, 1985)

Figure 2-8
Estimated Floodplain Volume of Sediments vs. TCDD Concentrations
Vertac Offsite, Jacksonville, Arkansas

Section 3
PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR WATERWAYS AND THE FLOOD PLAIN

This section identifies general response actions and identifies and screens remedial technologies for managing TCDD-contaminated wastes in two areas, the waterways (Bayou Meto and Rocky Branch) and the flood plains of these waterways. The purpose of this section is to screen available technologies to a manageable number that appear most promising at this time, which will be developed and analyzed later in the FS.

Various alternative remedial technologies can be applied to the management of hazardous wastes. Differences in waste chemistry, strength, volume, form, and relative toxicity, coupled with site-specific requirements, mean that a remedial action must be tailored to characteristics of the waste and site if the action is to be effective. The technologies presented are used to make comparative evaluations and estimate costs.

Remedial technologies are subdivided into three areas: management of migration, waste handling, and ultimate waste management. Technologies are presented and screened for each of these areas except waste handling. Waste handling methods, which include dewatering, water treatment, solidification, transportation, and temporary storage, are developed in Section 5. Technologies for waste handling were not preliminarily screened because the selection of the waste handling methods depends on the management of migration and ultimate waste management technologies selected. The cost of waste handling is a small part of the total cost of implementing a particular remedial action. The discussion on ultimate waste management technologies presented in this section also applies to the contaminated material in the wastewater facilities.

As discussed in Section 2, based on the recommendations of the ATSDR, the areas assumed to require attention in the waterways and the flood plain are those waterway sections that have TCDD levels greater than 1 ppb in the RI August 1984 sampling. These areas include the channel bottoms, banks, and the strips of land that border the channels. Later in the report, a sensitivity analysis will be presented that looks in part at the cost effects of varying the area of remediation. Therefore, some flood plain areas not adjacent to the waterways will be assumed to require remediation during the sensitivity analysis.

For purposes of this report, the following descriptions of waterways and the flood plain will be used for the investigation area:

- Waterways. Include the bottoms and banks of Rocky Branch and Bayou Meto.

- Flood Plain. Includes all land in the study area except the waterways and the wastewater facilities (presented in Section 4). The near-channel areas that are assumed to require remediation are also classified as flood plain.

SCREENING METHODOLOGY

Three sources of information were used in developing the preliminary screening criteria: the NCP; preliminary EPA policies; and "Hazardous Waste Management System; Dioxin-Containing Wastes," (U.S. EPA, January 14, 1985).

The NCP states that three broad areas should be considered during screening: costs, the environmental and health effects, and the acceptability, feasibility, and reliability of the technology to the specific application.

EPA policy and the NCP state that at least one remedial alternative that meets the following criteria will be developed in detail:

1. Alternatives specifying offsite storage, destruction, treatment, or secure disposal of hazardous substances at a facility approved under RCRA. Such a facility must also be in compliance with all other applicable EPA standards (e.g., Clean Water Act, Clean Air Act, Toxic Substances Control Act).

2. Alternatives that attain all applicable or relevant federal public health or environmental standards, guidance, or advisories.

3. Alternatives that exceed all applicable or relevant federal public health and environmental standards, guidance, and advisories.

4. Alternatives that meet the CERCLA goals of preventing or minimizing present or future migration of hazardous substances and protect human health and the environment, but do not attain the applicable or relevant standards. (This category must include an alternative that closely approaches the level of protection provided by the applicable or relevant standards.)

5. No action.

One response action may be able to provide multiple levels of protection with different degrees of implementation. The five criteria for remedial alternatives were considered when the technologies were initially screened since the technologies are assembled into remedial alternatives.

The January 14, 1985 regulation stated that management of TCDD-contaminated wastes shall be governed by the RCRA regulations. Therefore, an additional consideration for screening the technologies will be whether RCRA permitting for this management approach is anticipated in the foreseeable future. Currently, there are very few RCRA-permitted facilities for handling TCDD wastes, and very few management strategies are anticipated to be RCRA-permitted in the near future. The only interim status facilities[1] that may accept these wastes are:

- o Impoundments holding wastewater treatment sludges that are created in those impoundments as part of the plant's wastewater treatment system
- o "Enclosed waste piles"
- o Tanks
- o Containers
- o Certified incinerators
- o Certified thermal treatment units

The specific requirements for each of these facilities are addressed in the ruling. The ruling also notes that TCDD-

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[1] An interim status facility meets the following requirements:

- o Was in existence on November 19, 1980
- o Submitted a Notification of Hazardous Waste Activity by August 18, 1980
- o Submitted a RCRA Part A permit application by November 19, 1980

In addition, to retain interim status, all land disposal facilities were required (by November 8, 1985) to:

- o Submit a RCRA Part B permit application
- o Certify compliance with all applicable groundwater monitoring and financial responsibility requirements

contaminated wastes are specifically identified as candidates for being banned from land disposal within the next 2 years under the Hazardous and Solid Waste Amendment (HSWA) of 1984.

IDENTIFICATION OF GENERAL RESPONSE ACTIONS

The general response actions identified for the waterways and the flood plain are listed below:

- Leave-in-place
- Removal
- Local treatment
- Nonlocal treatment
- Local disposal
- Nonlocal disposal

The technologies identified for these general response actions are identified and screened in the remainder of this section.

DESCRIPTION AND SCREENING OF TECHNOLOGIES

Technologies for managing the TCDD-contaminated materials from the waterways and the flood plain are shown in Figure 3-1 and are discussed below. Table 3-1 summarizes the major advantages and disadvantages for each technology and indicates whether or not the technology was retained for further development.

MANAGEMENT OF MIGRATION

Two migration management approaches were considered for the contaminated materials: (1) leaving the contaminated materials in place, and (2) removing the contaminated materials. Several technologies are discussed for each approach.

Leave-in-Place Technologies

The technologies that were considered for leaving the material in place were:

- No action
- Restrict access and monitor migration
- In-place containment
- In-place treatment

No Action. The no action technology is just that--nothing would be done to limit the exposure to or the migration of the contaminated materials presently in the waterways and flood plain. This is the least expensive technology but also poses long-term health and environmental risks based on the findings of the EA. This alternative was retained for

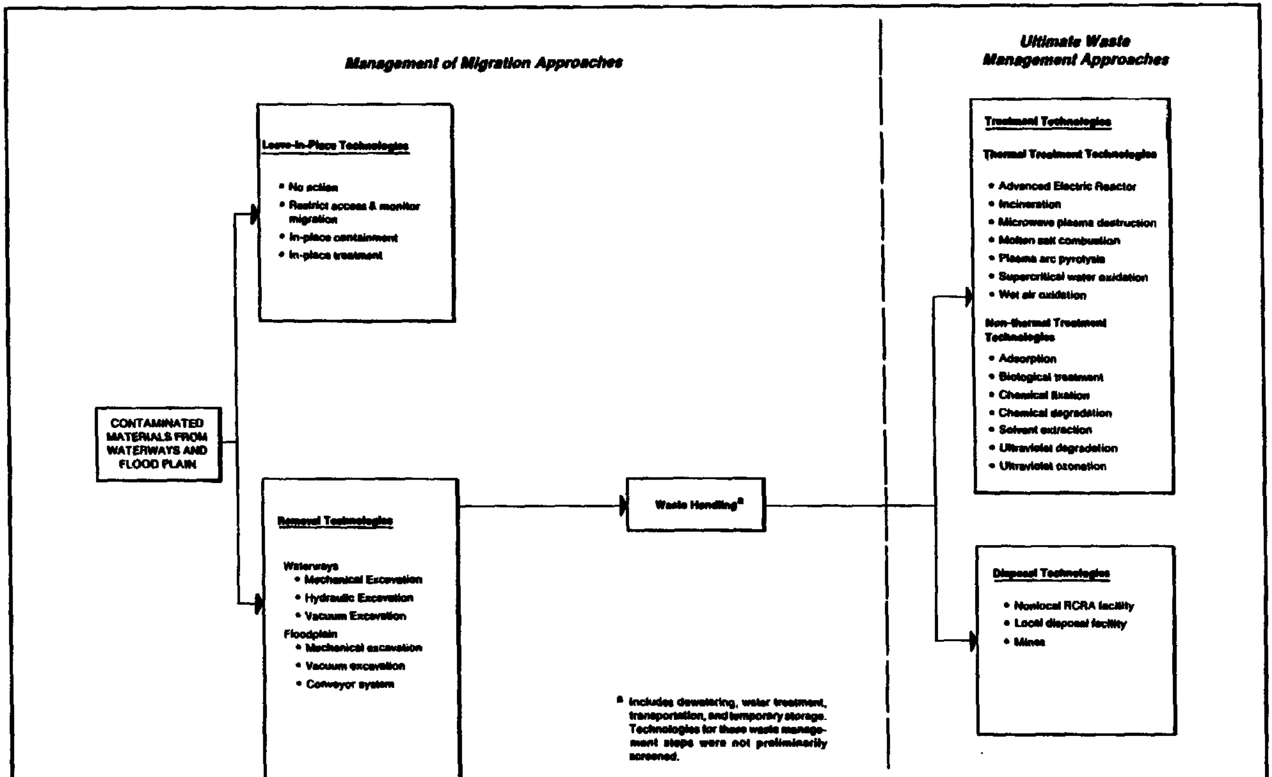

Figure 3-1
Remedial Technologies Considered
During Preliminary Screening
Waterways and Flood Plain

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Table 3-1
PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES--
WATERWAYS AND THE FLOOD PLAIN, MANAGEMENT OF MIGRATION

Technology	Advantages	Disadvantages	Status
LEAVE-IN-PLACE TECHNOLOGIES			
No Action	o Least expensive technology	o Doesn't reduce future exposure to or migration of TCDD	Retained[a]
Restrict Access and Monitor Migration	o One of the least costly technology o Reduction in TCDD exposure to humans and wildlife o Monitoring results will help determine future actions	o Undetected TCDD migration may occur o TCDD exposure to some wildlife will continue	Retained
In-Place Containment Technologies			
Waterways			
Rechannelization	o Reduces rate of migration o TCDD is taken out of the aquatic environment o Human exposure to TCDD is less likely	o Aquatic system temporarily disrupted	Retained
Culvert	o Migration of TCDD is reduced o Human and fish exposure to TCDD is less likely	o Impractical for the large flows in Bayou Meto o Excavation of contaminated sediments is required to provide an adequate bearing surface	Eliminated
In-place Casting of Concrete	o Migration of TCDD is reduced o Human and fish exposure to TCDD is less likely	o Concrete will deteriorate with time o Waterway biota destroyed and not replaced	Eliminated

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Table 3-1
(continued)

Technology	Advantages	Disadvantages	Status
Flood Plain			
Cover with geotextile and soil	o Some reduction in migration of and exposure to TCDD o Vegetation can continue to grown in flood plain	o Routine maintenance required	Retained
Stabilize with fixants	o Fixant materials are readily available o Organic wastes are adsorbed or mechanically trapped	o Soil cannot sustain normal plant growth o Deterioration of fixants in the future o Some fixants may be difficult to incorporate o Increased volume of waste with inorganic fixants	Eliminated
In-Place Treatment Technologies		o No proven technology	Eliminated
REMOVAL TECHNOLOGIES			
Waterways			
Mechanical	o Proven technology o High productivity rate at low unit excavation cost	o Extent of overexcavation is high o Spillage of contaminated materials is expected	(b)
Hydraulic	o Proven technology o Efficient removal method	o Removes sediments as a slurry with a low solids content thus increasing volume of material to handle in subsequent steps	(b)
Vacuum	o Extent of overexcavation is low o Very efficient removal method	o Experience in waterways is limited o High unit excavation cost	Retained[b]

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Table 3-1
(continued)

Technology	Advantages	Disadvantages	Status
Flood Plain			
Mechanical	o Proven technology	o Requires deforestation o Overexcavation greater than for other two technologies	Eliminated
Vacuum	o Very efficient removal method o Deforestation only required for access road	o Unit cost is about twice as much as for conveyor system o Requires rototilling when excavating deeper than about 4 inches	Eliminated
Conveyor System	o Very efficient removal method o Deforestation only required for access roads o Unit cost is about one-half as much as for vacuum excavation	o More materials handling required than for vacuum excavation	Retained

[a]Technology was retained since EPA's policy is to retain the no action alternative for further development and evaluation.
[b]Unable to select a removal technology that is decisively the most favorable due to insufficient site information. Selected vacuum excavation for further development and evaluation.

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further consideration since EPA's policy is to retain the no action alternative for development and evaluation for a basis of comparison with other alternatives.

Restrict Access and Monitor Migration. This technology would restrict access to and use of the contaminated waterways and flood plain. The contaminated areas would be fenced off, and no trespassing signs would be posted. Migration of TCDD from known contaminated sites would be monitored. Advantages of this technology are its relatively low cost and the reduction in exposure of TCDD to animals and humans. Also, by monitoring TCDD migration, it can be determined what, if any, future actions are needed to provide the desired level of protection. The disadvantages of this technology include undetected migration of TCDD may occur; prevention of exposure to birds, fish, aquatic creatures, and downstream people and wildlife is not provided; an economic loss will be experienced due to discontinued use of land and waterways; and some deforestation is required to install the fence.

This technology was retained for further consideration since the threat to human health would be reduced at a relatively low cost. Also, monitoring provides a means to determine if additional actions are desirable in the future.

In-Place Containment. In-situ containment includes technologies that secure contaminated sediments in place to prevent or minimize further migration of contaminated materials. Considered technologies for the waterways include rechannelization, placement of a culvert for the water to flow through, and in-place casting of concrete on the stream beds. Technologies for the flood plains include covering the contaminated area with geotextile and gravel and/or soil, or applying a fixation material such as a cement or gel.

Rechannelization involves filling in the existing channel with excavated soils produced while excavating a new parallel channel. This would significantly reduce the rate and extent of migration. Also, TCDD would be taken out of the aquatic environment, thereby reducing the extent of biological uptake of TCDD.

The size and flow characteristics in Bayou Meto render placing a culvert in the Bayou impractical. Therefore, this technology was not considered further.

Concrete could be cast in place without dewatering and would reduce further transport of contaminated materials downstream. However, this technology was eliminated because the concrete liner would progressively deteriorate with time. Also, a concrete liner would change the flow characteristics and ecosystem of the stream.

Placing geotextile and topsoil on the flood plains would reduce migration of and exposure to TCDD-contaminated soil. The barrier would be subject to deterioration due to natural mechanisms such as erosion, wildlife activities (digging), and root penetration. Thus routine maintenance would be required to maintain the integrity of the cover.

Fixation materials are discussed under Ultimate Waste Management-Chemical Fixation. In-place containment with fixation materials was not retained for further development because the "fixed-soil" will not be able to support normal biological growth.

Based on the concerns previously expressed, the only in-place containment technologies retained for further consideration are rechannelization of the waterways and covering the flood plain with geotextile and soil.

In-place treatment. Chemical or biological stabilization of the waterway and flood plain sediments is not a proven technology and therefore was not considered further.

Remove Contaminated Material

Criteria considered when evaluating technologies for removing the contaminated sediments in the waterway and the contaminated soils in the flood plain included the following:

- Removal technology must be compatible with site conditions (such as accessibility and ground cover).
- The amount of overexcavation should be limited.
- Removal of contaminated material should be as complete as possible--that is, loss of contaminated material due to such things as spillage and dust emissions should be minimized.
- Costs should be minimized.

Waterways. Three removal technologies were considered for the waterways: mechanical dredging, hydraulic dredging, and vacuum excavation.

Mechanical dredging involves using draglines, clamshells, backhoes, or similar equipment. Mechanical dredging can take place instream without diversion when the flow is low and shallow. Sediments are dispersed in the water column during excavation making downstream migration of sediments during excavation probable. Dispersed sediments could be captured with such devices as silk curtains. A more efficient mechanical excavation technology with broader application is stream diversion with temporary cofferdams followed by dewatering and mechanical excavation.

Hydraulic dredges include plain suction, cutterhead, dustpan, and hopper. Hydraulic dredges remove and transport sediment in liquid slurry form. Slurries of 10- to 20-percent solids by wet weight are common in standard hydraulic dredging operations. Solids removal at a low solids content is a major disadvantage since it increases the required sizes of subsequent waste handling facilities. Also, debris larger than about 4 inches would have to be removed prior to dredging it. This would require dewatering the channel, removing large debris, reflooding the channel, and then hydraulically dredging it. Therefore, hydraulic dredging does not eliminate the need for dewatering the channel. Hydraulic dredges that minimize suspension of sediments during dredging operations and that loosen consolidated material are available.

Vacuum excavation uses equipment that is similar to a vacuum truck that picks up oily wastes but the vacuum is much stronger. The truck-mounted system uses a double filter on the air handling system. The vacuum pressure is dropped prior to filtration so that a High Efficiency Particulate Air (HEPA) filter followed by a bag filter may be used. The filters must be changed daily and are disposed of with the contaminated soil. Dewatering and removal of large debris is required prior to vacuum excavation. When excavating deeper than about 4 inches in consolidated material, vacuum excavation would probably need to be supplemented with rototilling.

With the available site information, we cannot determine which removal technology is most attractive. If removal of the contaminated materials is selected, the actual removal technology would be determined during the design or construction phase. Hydraulic excavation requires the largest subsequent waste handling facilities, such as dewatering. The unit cost for vacuum excavation is about 15 times greater than for mechanical excavation; however, overexcavation would be greater for mechanical excavation, thereby increasing the total cost for subsequent waste handling operations and offsetting the lower excavation cost. The amount of sediment handling is less for vacuum excavation than for mechanical excavation because the sediments are directly pumped into a haul truck.

Vacuum excavation was the only removal technology for the waterways retained for further development.

Flood plain. Three excavation technologies were considered for the soils in the flood plain--mechanical, vacuum, and conveyor. Mechanical excavation requires the most material handling, has the highest potential for fugitive dust of the three alternatives considered and would probably have the greatest amount of overexcavation. Mechanical excavation would also require deforestation prior to excavation whereas the other two methods would not. When excavating deeper than about 4 inches in consolidated material, vacuum excavation, which was described previously, would be supplemented with rototilling. The conveyor system is better suited for deep excavation and also costs about one-half as much as vacuum excavation. The efficiency in removing sediments is slightly less for the conveyor system. The extent of overexcavation for vacuum excavation and the conveyor system is about the same. The conveyor system was the removal technology retained for further development since its overexcavation is expected to be less than for mechanical excavation, deforestation is not required (this is primarily a concern when remediating the flood plain not adjacent the channels), and it has a lower cost than vacuum excavation.

ULTIMATE WASTE MANAGEMENT

The ultimate waste management general response actions that were identified are local and nonlocal treatment and local and nonlocal disposal. This section discusses ultimate waste management technologies for these general response actions, although a differentiation is not made between local and nonlocal treatment.

Ultimate waste management technologies for contaminated materials removed from the waterways and flood plains and from the wastewater facilities are presented. The differences in the characteristics of the materials removed from the waterways and flood plain and from the wastewater facilities do not affect the screening of the ultimate waste management technologies at this preliminary stage of development. Table 3-2 summarizes the major advantages and disadvantages for each technology and indicates whether the technology was retained for further development.

Two broad categories of ultimate waste management were considered: treatment and disposal. This section briefly discusses technologies under each of these categories. Detailed discussions of the treatment technologies are given in Appendix A.

The technologies are not necessarily exclusive of each other. A combination of processes may be required to achieve the remedial goals. For instance, the contaminated sludges may first be stabilized and then stored in an offsite disposal facility.

TCDD treatment is a pioneering field with most technologies in the development phase. Therefore, many of the discussed technologies are not currently developed enough to determine with reasonable certainty whether they are technically and economically feasible. Thus, some of the technologies may be reconsidered after future development.

Table 3-2
PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES
ULTIMATE WASTE MANAGEMENT

Technology	Advantages	Disadvantages	Status
THERMAL TREATMENT TECHNOLOGIES			
Advanced Electric Reactor	o Pilot studies in Missouri had successful results	o No full-scale operating data o Extensive materials handling required o Residue, if not delisted, must be handled as a hazardous waste o High operating costs	Eliminated
Incineration	o Process has been demonstrated to provide greater than 99.9999% destruction of TCDD in soils in Missouri o Incinerators have been certified for TCDD destruction	o Potential emissions o Extensive materials handling required o Residue, if not delisted, must be handled as a hazardous waste o High operating costs	Retained
Microwave Plasma Destruction	--	o Process is still at research level o Residue, if not delisted, must be handled as a hazardous waste o High operating costs	Eliminated
Molten Salt Combustion	o Can be used for highly toxic inorganic or halogenated wastes	o Process is still at research level o Residue, if not delisted, must be handled as a hazardous waste o High operating costs	Eliminated
Plasma Arc Pyrolysis	--	o Process is still at research level o Residue, if not delisted, must be handled as a hazardous waste o High operating costs	Eliminated
Supercritical Water Oxidation	--	o Has not been tested for TCDD wastes o Residue, if not delisted, must be handled as a hazardous waste o High operating costs	Eliminated

Table 3-2
(continued)

Technology	Advantages	Disadvantages	Status
Wet Air Oxidation	o Commercially available	o Products have not all been identified o Highly pressurized system imposes safety risks o Residue, if not delisted, must be handled as a hazardous waste o High operating costs	Eliminated
NONTHERMAL TREATMENT TECHNOLOGIES			
Adsorption	--	o Regeneration or disposal of spent activated carbon o Uncertainty of completeness of extraction and activated carbon adsorption of TCDD o Has not been demonstrated on a large scale nor for low TCDD levels that are at the Vertac Offsite	Eliminated
Biological Treatment	o Low energy-intensive technology o Environmentally attractive technology	o Not proven beyond laboratory-phase o A slow process o Has not been demonstrated on a large scale nor for as low of TCDD levels at the Vertac Offsite	Eliminated
Chemical Fixation	o Proven technology o Plentiful raw materials	o Increase in volume of waste o Chemicals may leach with time o Has not been demonstrated on a large scale nor for low TCDD levels that are at the Vertac Offsite	Eliminated

Table 3-2
(continued)

Technology	Advantages	Disadvantages	Status
Chemical degradation	--	o Has not been demonstrated to be a successful means of TCDD degradation in soil to the levels required o Has not been demonstrated on a large scale nor for low TCDD levels that are at the Vertac Offsite	Eliminated
Solvent Extraction	o TCDD in a solvent is easier to destroy than when attached to solids	o Has not been demonstrated on a large scale o Uncertainty of extraction efficiency o Has not been demonstrated on a large scale nor for low TCDD levels that are at the Vertac Offsite	Eliminated
Ultraviolet Degradation	--	o Uncertainty of destruction efficiency o Has not been demonstrated on a large scale nor for low TCDD levels that are at the Vertac Offsite	Eliminated
Ultraviolet Ozonation	--	o Products are unidentified o Uncertainty of destruction efficiency o Has not been demonstrated on a large scale nor for low TCDD levels that are at the Vertac Offsite	Eliminated

Table 3-2
(continued)

Technology	Advantages	Disadvantages	Status
DISPOSAL TECHNOLOGIES			
Nonlocal RCRA Facility	o Well-developed technology o Extensively used for hazardous wastes	o Future acceptance by regulatory agencies is uncertain o Long haul distance o Requires extensive monitoring o Presently no RCRA facility is permitted to handle TCDD wastes	Retained
Local Disposal Facility	o Well-developed technology o Short haul distance o Has been extensively used for hazardous wastes	o Requires extensive monitoring o Future acceptance by regulatory agencies is uncertain o Potential local resistance to the idea	Retained
Mines	o Wastes could be easily inspected and removed, if desired o Not a land-intensive technology	o Known mines in Arkansas are not dry and thereby are not suitable for hazardous waste disposal o Currently prohibited	Eliminated
In-place Containment in Wastewater Facilities[a]	o Disposal facilities are already available o Reduces future exposure to and migration of TCDD	o A sub-RCRA technology o Extensive material handling required	Retained

[a]This technology only applies to the contaminated material in the wastewater facilities.

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The treatment technologies are classified into two categories: thermal treatment methods and nonthermal treatment technologies. These are briefly described and then the results of the preliminary screening are presented.

Thermal Treatment Technologies

Advanced Electric Reactor. Waste in a central porous cylinder is heated by radiation from surrounding electrodes to 3,000° to 5,000°F. The central cylinder is made of porous carbon or ceramic material transparent to the infrared radiation from the electrodes and protected from thermal or chemical destruction through contact with the heated waste by a fluid film of inert gas that is drawn through the inside of the cylinder. This process results in a rapid and complete waste heating that allows for a high degree of combustion completeness. A high degree of process control is possible since the radiation source is electricity. Huber Corporation has reduced TCDD concentrations in contaminated soil from 80 ppb to less than 0.1 ppb with an advanced electric reactor at Times Beach, Missouri (see Appendix A).

Incineration. Soil-bound TCDD can be incinerated in two different forms: directly as raw TCDD contaminated soil or it can be treated in a solvent extraction process and then the extraction residue is incinerated. Since the residue from the solvent extraction process will include a large amount of inert solids in a solvent, which will have to be dealt with, only incineration of the raw TCDD-contaminated soil will be addressed.

Incineration takes place in an environment of excess oxygen or a starved oxygen environment (pyrolysis) at temperatures and material retention times sufficient to destroy the chlorinated hydrocarbon molecules. The process consists of two basic steps: (1) the TCDD is vaporized from the soil in a primary combustion chamber and (2) the vapor is destroyed in a secondary combustion chamber (afterburner). A size reduction facility for proper preparation of the soil is required before the material can be fed to the combustion chamber. Also, equipment to control air and water emissions from an incineration facility will be required.

Incineration has been shown to be a viable treatment method for PCB's and successful trial burns and field trial burns of TCDD-contaminated sediments have been conducted in Missouri (See Appendix A).

Microwave Plasma Destruction. Organic compounds are broken down into smaller molecules when combined with partially ionized gas produced by microwave-induced electron reactions. This technology needs development through pilot and large-scale tests to determine the economical feasibility and technical success in treating large volumes of TCDD-contaminated materials.

Molten Salt Combustion. Chlorinated hydrocarbon wastes are injected in a continuous feed below the surface of a 800°C to 1000°C molten salt bath, which contains a mixture of sodium or potassium carbonate and 10-percent sodium sulfate by weight. The chlorinated hydrocarbons oxidize in the molten salt to CO_2, water, and sodium chloride. Materials generated during the combustion process can be retained, and the spent molten salt can be either regenerated or landfilled. A particulate baghouse is necessary for the off gas. Ash and any metal, phosphorous, halogen, or arsenic salts built up in the melt must be removed. This technology has not been laboratory tested for various TCDD-contaminated materials and is typically not suited for inert solids like soils.

Plasma Arc Pyrolysis. The plasma arc process uses energy from ionized gas molecules that are created by an electrical current discharge through a vortex of low-pressure gas, to destroy organic molecules. Temperatures equivalent to 50,000°K are achieved in the plasma, and rapid decomposition follows exposure to waste materials. The primary products from TCDD destruction would likely be carbon monoxide, carbon dioxide, hydrogen chloride, hydrogen gas, and water vapor. Gas volumes supplied to the reactor are on the order of 5 percent of the gas volumes required by conventional incineration. Scrubbers are needed for exit gases from processing halogenated wastes. Laboratory-scale tests have shown PCB destruction from liquid wastes in excess of 99 percent. Before plasma arc pyrolysis could be used to dispose of TCDD-contaminated sediment, a change in the feed mechanism and additional testing would be necessary.

Supercritical Water Oxidation. Supercritical water oxidation uses air or oxygen in water above its critical temperature and pressure [374°C and 218 atmosphere (atm)] to destroy organics. Under these conditions, oxygen and hydrocarbons are almost completely miscible with water: the salts precipitate out. The waste is slurried, pressurized, and then educted into the supercritical water reactor. A base is added to the system so that anions present can be reacted to salts. Salts, water, carbon dioxide, and traces of organic feed exit the reactor. Supercritical water oxidation has not been laboratory tested on TCDD-contaminated materials.

Wet Air Oxidation. Wet air oxidation is a physical/chemical treatment process for the destruction of organic compounds in water under high temperatures and pressures. Under these conditions, organics are oxidized to alcohols, aldehydes, acids, and ultimately to carbon dioxide and water by injecting oxygen into the process. Typical operating temperatures and pressures are 150° to 350°C and 500 to 2,500 pounds per square inch gauge (psig). Sometimes the reaction is catalyzed with a bromide-nitrate solution (catalyzed wet air oxidation).

The primary concerns associated with wet air oxidation of TCDD-contaminated sediments are:

- o Material preparation to reduce the particle size of the sediments
- o The high amount of supplemental energy required due to the low organic content of the soil
- o The unidentified products formed during the oxidation reactions
- o The safety risks involved with a highly pressurized system

IT Enviroscience reported a 99 percent reduction in TCDD in a laboratory test with the catalyzed wet air oxidation process. Similar reductions were observed in a pilot plant for PCB destruction.

<u>Nonthermal Treatment Technologies</u>

<u>Adsorption</u>. This process would first involve extraction of the TCDD from the sediment, which is discussed under the "Solvent Extraction." The TCDD-containing solution is then passed through granular activated carbon (GAC) beds and the TCDD is adsorbed onto the GAC. The appropriateness of this technology for treating TCDD-contaminated sediment is contingent on (1) the extraction efficiency of the TCDD from the sediment and (2) the regeneration/disposal of the exhausted GAC.

<u>Biological Treatment</u>. The EPA is investigating biological degradation of hazardous waste. The research program has examined four major areas:

- o Recombinant DNA (using yeast cultures)
- o Plasmid-assisted molecular breeding (using bacteria)
- o Fungal degradation (using white rot fungi)
- o Microbial degradation

The research program has shown some encouraging results thus far, but the EPA predicts that it will be several years before biological treatment will be developed to the point at which it can be used to clean up a TCDD site. Some of the important results to date are summarized below.

- o Dr. A.M. Chakrabarty of the University of Illinois Medical Center has had success in the laboratory biodegrading 2,4,5-T (which, like TCDD, is difficult to degrade) with pseudomonas bacteria.

- o White rot fungi (phanerchaete chrysoporium) has been tested for degradation of chlorinated hydrocarbons. Test results in the aqueous phase have demonstrated that 4 percent of the 2,3,7,8-TCDD is converted to carbon dioxide in 60 days. The EPA plans to conduct soil tests with white rot fungi at Shenandoah Stables in eastern Missouri.

- o Test results with the white rot fungi have also demonstrated that DDT (which, like TCDD, is difficult to degrade) can be reduced by 99 percent in 75 days. Glucose was used, in addition to the white rot fungi, as a food source (co-metabolite) during the experiments. A co-metabolite is required for degradation of the chlorinated hydrocarbons. One co-metabolite that will be tested at Shenandoah stables is sawdust.

<u>Chemical Fixation</u>. The fixation of organic wastes in soils has been attempted in many ways. The immobilization of TCDD-contaminated soil may be achieved by one or a combination of these processes. The methods can be grouped into three categories: inorganic, organic, and encapsulation. Encapsulation is discussed under "Disposal." Chemical fixation may be used in place (see "In-Place Containment") or used after the material has been removed and prior to storage.

The common inorganic fixation techniques use Portland cement, pozzolanic (fly ash) materials with or without lime or cement, and sorbent clays. The advantages of these processes are plentiful raw materials, low cost, the fact that the organic wastes are adsorbed or mechanically trapped (although both may allow leaching of some wastes), and proven technology. Disadvantages include the increased volume of the original waste, which results in increased mixing, packaging, transportation, and disposal site expense.

Stabilization chemicals are available that, in general, react with moisture in the soil or an aqueous catalyst to form a hydrophobic cross-linked polymer-based gel. The semisolid gel coats and binds the soil particles together. The resulting gel-soil mixture then becomes a barrier to water infiltration.

The advantages some of the organic fixants offer are that they are easy to mix, they penetrate soil much like water (since they have a viscosity similar to water), they can be applied by spraying, and they are generally nontoxic when handled properly. Also, most of these grouts seek and react with water in the soil or groundwater, form irreversible compounds of indefinite life (under proper conditions), do not substantially increase the volume of the treated soil, and their use is proven. On the negative side, grouts are more expensive than other stabilization methods, they are sensitive to freeze-thaw and wet-dry conditions, and some grouts deteriorate under ultraviolet light.

Chemical Degradation. The EPA's Office of Research and Development has been researching the chemical degradation of TCDD in soil and has focused on a group of reagents known as APEG reagents. The "A" in APEG refers to an alkaline element such as sodium or potassium, while "PEG" refers to polyethylene glycol. The most promising APEG reagent identified thus far is KPEG (potassium polyethylene glycol). The EPA has investigated four major chemical reagent application methods:

- Extraction--patterned after the Acurex solvent extraction process
- Injection--consisting of an injection well, a recovery well(s), and reagent recovery step
- In situ--consisting of reagent application and soil cultivation
- Slurry--consisting of a reaction step, reagent recovery, and soil washing

The laboratory tests conducted to date show that TCDD with APEG reagents, but that the destruction efficiencies are not yet adequate to clean up a contaminated site. For example, a single APEG application reduced TCDD concentrations by approximately 30 percent in soil with initial concentrations of approximately 300 ppb of TCDD. Two applications with APEG reagent reduced the TCDD by approximately 60 percent, to about 100 ppb.

The EPA's research shows that the soils should be finely ground, that the reagent should be applied in sufficient quantities to saturate the soils, and that the APEG reagents are more effective when heated.

The EPA has researched the use of APEG both indoors and outdoors at Shenandoah Stables in Missouri. Preliminary data from the indoor study, completed in 1985, indicate that some reduction in 2,3,7,8-TCDD concentration has been achieved in the field.

During the outdoor study, the EPA will test a radio frequency (RF) heating unit on the soil to improve the efficiency of APEG. The RF test unit is a 5-kilowatt (kW) unit that will heat a 20- by 20-foot plot of soil to 70°C in 7 days.

The APEG reagent costs are estimated to be $1,000 per acre for an application that will penetrate the soil 6 in. The cost for the operation of the RF unit will be determined during the outdoor study. The efficacy of the APEG reagent to clean up TCDD sites will be determined at the completion of the outdoor study.

Solvent Extraction. Solvent extraction of TCDD from soil is achieved by intimately contacting adequately processed soil with a solvent that will preferentially remove TCDD from soil to a desired level in a specified contacting time. The TCDD-contaminated solvent can then be treated by one of the destruction technologies discussed.

Concerns with solvent extraction are that no pilot or large-scale processes using solvents to extract TCDD from soil have been used and extraction efficiency varies depending on the type and age of the contaminated material. However, TCDD was extracted from contaminated sludge in distillation bottoms with hexane in a full-scale solvent extraction process at the Syntex Agribusiness facility in Verona, Missouri. The TCDD concentration in the sludge was reduced from 343,000 ppb to 100 to 500 ppb.

Ultraviolet Degradation. Ultraviolet degradation is the process of breaking chemical bonds with ultraviolet (UV) light. Ultraviolet degradation is achieved by exposing a compound in a suitable medium to a sufficient intensity of UV light from a specific wavelength range.

Ultraviolet Ozonation. Ultraviolet ozonation is a combination of breaking chemical bonds with ultraviolet light and oxidation of the activated organic compounds with ozone. It is achieved by bringing ozone into contact with the liquid organic waste in the presence of ultraviolet radiation of a specified wavelength range and intensity.

Screening of Treatment Technologies

According to the January 14, 1985 EPA ruling, the only treatment technologies for TCDD-contaminated materials that are currently being considered for regulation are interim status thermal treatment units (including incinerators).

The nonthermal treatment technologies were not considered further because they have not been demonstrated on a large scale or for TCDD levels as low as that which occurs at the Vertac offsite.

Several thermal treatment methods were presented. For purposes of the FS, only rotary kiln incineration was considered further. This selection should not be interpreted as meaning that rotary kiln incineration is the optimum or only feasible thermal treatment method. Rather, rotary kiln incineration was chosen because (1) rotary kiln incineration was successfully demonstrated at the Denney Farm site in Missouri, (2) a rotary kiln incinerator will be used on the Vertac site and may also be available for treating offsite contaminated materials, (3) permit approval of this technique is expected, and (4) its use at Vertac will indicate the cost associated with thermal treatment.

Disposal Technologies

These technologies consist of disposing the TCDD-contaminated materials. RCRA regulations on TCDD became effective on July 15, 1985. RCRA requires that TCDD waste be placed only in facilities fully compliant with 40 CFR 264. As of this writing, no commercial facilities have RCRA Part B permits for handling TCDD, but several may receive such permits in the future. Also, as noted previously in this section, TCDD-contaminated wastes are candidates for being banned from land disposal in 2 years under the HSWA.

Three disposal technologies were considered for contaminated material from the waterways and flood plain and from the wastewater facilities--nonlocal disposal in a RCRA facility, local disposal and disposal in mines. Nonlocal disposal involves transporting the TCDD-contaminated material to an offsite commercial landfill facility. A commercial landfill with a RCRA Part B permit was assumed to be available in the future. Local disposal involves constructing a permanent disposal facility at the WWTP site or in the contaminated flood plain.

Disposal in mines involves placing the contaminated material in abandoned mines. The mines must have large caverns, be dry and stable, and facilitate easy access for inspection of the wastes. Bob Blanz of the ADPC&E indicated that he knows of no mines with these properties in Arkansas. Regulations for disposal of hazardous waste in mines do not exist and the lack of regulations disallows such disposal.

In-place containment of contaminated material from the wastewater facilities in existing wastewater facilities was also considered. The contaminated material in the sewers would be contained in place by completely plugging the sewer system with concrete. The remaining contaminated material from the wastewater facilities would be disposed of in the oxidation ponds and the ponds would be capped. Some of the contaminated material would have to be dewatered and solidified to adequately support a cap. This disposal alternative is a sub-RCRA alternative.

The disadvantages of the disposal alternatives include long-term monitoring requirements, loss of land for other uses (except the mine disposal alternative), the uncertainty of future acceptance by regulatory agencies, the difficulty and expense of retrieving the waste in the future for additional treatment if desired, and public acceptance of disposing these wastes in "their backyard."

Disposal of hazardous wastes is commonly used and, if the facility is properly designed, maintained, and monitored, disposal can be a successful remedial measure.

Local disposal, nonlocal disposal in a RCRA facility, and disposal of contaminated materials from the wastewater facilities in existing wastewater facilities were retained for further consideration.

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Section 4
PRELIMINARY SCREENING OF
REMEDIAL TECHNOLOGIES FOR WASTEWATER FACILITIES

This section identifies general response actions and identifies and screens technologies for managing the TCDD-contaminated wastes in the wastewater conveyance and treatment facilities. The purpose of this section is to reduce the available technologies to a manageable number of the most attractive technologies at this time, which will be developed and evaluated further in the FS. The technologies are examples of technologies that are presented to make comparative evaluations and to estimate cost.

The primary wastewater conveyance and treatment facilities requiring remediation are the aeration basin, oxidation ponds, the outfall ditch from the oxidation ponds to the Bayou Meto, the abandoned wastewater treatment plant, and the sewer system (see Figures 2-3, 2-4, 2-5, and 2-6).

The screening methodology and format are the same as for the previous section. Technologies are subdivided into three areas: management of migration, waste handling, and ultimate waste management. Technologies are presented and screened for management of migration. As for the waterways and flood plain, methods for waste handling are developed in the subsequent sections. The descriptions and evaluations of the ultimate waste management technologies are the same as for the contaminated materials from the waterways and flood plain. The reader is referred to Section 3 for a discussion on the preliminary screening of ultimate waste management technologies.

GENERAL RESPONSE ACTIONS

The general response actions identified for the wastewater facilities are listed below:

- Leave-in-place
- Removal
- Local treatment
- Nonlocal treatment
- Local disposal
- Nonlocal disposal

The remainder of this section identifies and screens technologies for the leave-in-place and removal response actions. Section 3 addressed technologies for treatment and disposal.

DESCRIPTION AND SCREENING OF TECHNOLOGIES

The technologies for managing the TCDD-contaminated materials from the wastewater facilities are shown in Figure 4-1 and are discussed below. Table 4-1 summarizes the major

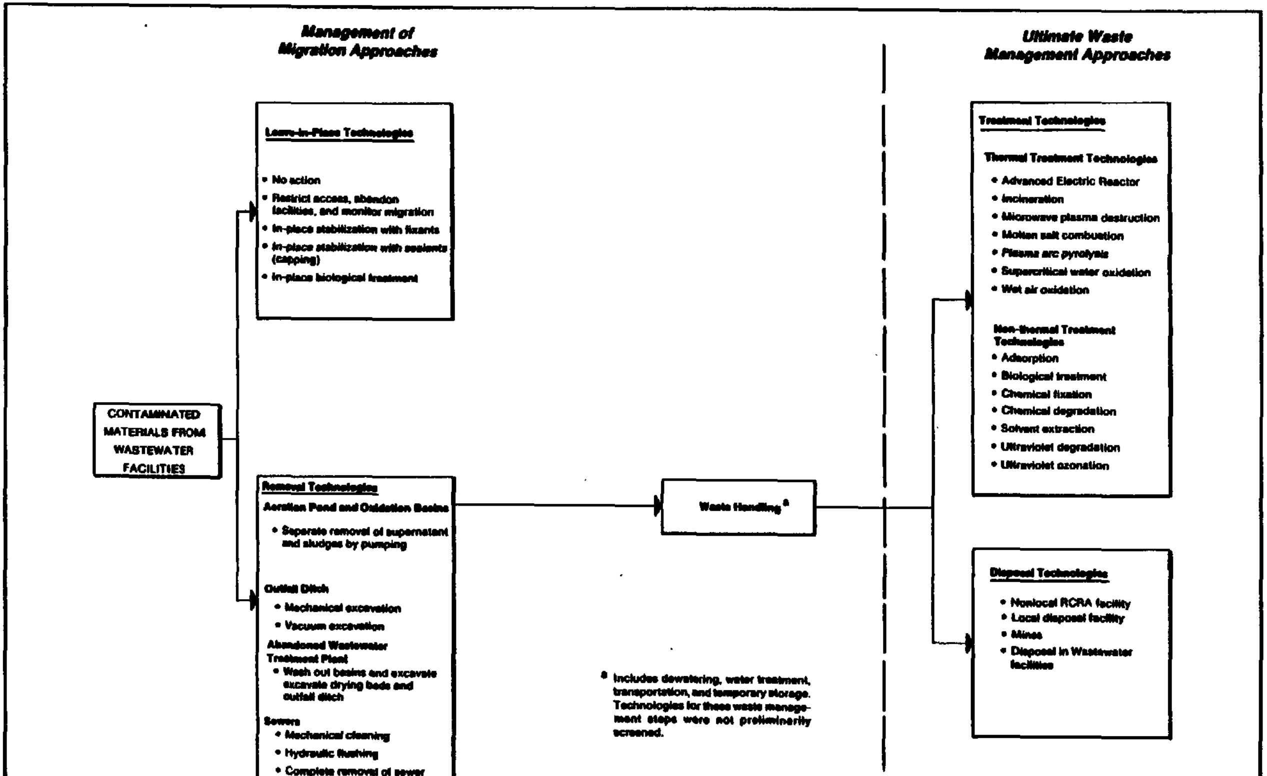

Figure 4-1
Remedial Technologies Considered During Preliminary Screening
Wastewater Facilities

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Table 4-1
PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES
WASTEWATER FACILITIES
MANAGEMENT OF MIGRATION

Technology	Advantages	Disadvantages	Status
LEAVE-IN-PLACE TECHNOLOGIES			
No Action	Least expensive technology	Provides no protection from future exposure to or migration of TCDD-contaminated material	Retained[a]
Restrict Access, Abandon Facilities, and Monitor Migration	Low cost. Reduces future exposure to and migration of TCDD-contaminated material.	Some migration of TCDD-contaminated material will continue.	Retained
In-Place Stabilization With Fixants	Reduces future exposure to and migration of TCDD-contaminated material.	Volume increase. Difficult to incorporate fixants in-place with oxidation pond sludges.	Eliminated
In-Place Stabilization With Sealants (capping)	Reduces future exposure to and migration of TCDD-contaminated material.	Sludges must first be solidified, which requires removal, before capping basins.	Eliminated
In-Place Biological Treatment	Would provide a relatively low-cost method of TCDD destruction.	Has not been proven on a full-scale basis	Eliminated
REMOVAL TECHNOLOGIES			
Aeration Pond and Oxidation Basins			
Separate Removal of Supernatant and Sludges by pumping	Allows supernatant and sludges to be treated separately; subsequent actions with supernatant are expected to be less costly than for sludges.	Requires more careful techniques to remove separately.	Retained
Outfall Ditch			
Mechanical	Excavation cost is less. Has been used successfully at dioxin sites in Missouri.	Depth of excavation is more difficult to control.	Retained
Vacuum	Depth of excavation is more easily controlled. Loss of material due to spillage and dust emissions is less likely.	Excavation cost is higher.	Eliminated

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Table 4-1
(continued)

Technology	Advantages	Disadvantages	Status
<u>Abandon Wastewater Treatment Plant</u>			
Clean out basins and excavate drying bed and outfall ditch	Expected to adequately remove contaminated material	--	Retained
<u>Sewers</u>			
Mechanical Cleaning	Removes large obstructions.	Inadequate as sole cleaning method, must be succeeded with hydraulic flushing.	Eliminated
Hydraulic Flushing	Efficiently transports debris to manholes where it can be removed with suction equipment. A cutterhead attachment can effectively remove larger debris such as roots.	Generates a large volume of water that must be subsequently separated from the contaminated solids.	Retained
Complete Removal of Sewer Infrastructure and Bedding Material	If the granular material in the pipe zone is contaminated, this provides more protection to the environment.	More material must be subsequently handled. A new parallel sewer system must be installed.	Retained

[a]Technology was retained since EPA's policy is to retain the no action alternative for further development and evaluation.

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advantages and disadvantages for each technology and indicates whether the technology was retained for further consideration.

MANAGEMENT OF MIGRATION

Two management of migration general response actions were considered for the contaminated materials--leaving the contaminated materials in place and removing the contaminated materials. Several technologies are discussed for each approach.

Leave-in-Place Technologies

Technologies for leaving the contaminated material in-place that were considered are:

- No action
- Restrict access, abandon facilities, and monitor migration
- In-place stabilization with fixants
- In-place stabilization with sealants (capping)
- In-place biological treatment

No Action. The no action technology is just that--nothing would be done to limit the exposure to or the migration of the contaminated materials presently in the wastewater facilities. This is the least expensive technology but it also poses long-term health and environmental risks. This technology was retained for further consideration since EPA's policy states that the no action alternative should be retained for development and evaluation for a basis of comparison with other alternatives.

Restrict Access, Abandon Facilities, and Monitor Migration. This technology involves restricting access to the contaminated facilities by installing a fence around the aeration basin, oxidation ponds, and abandoned wastewater treatment plant. Warning signs would be posted. Abandonment of the facilities would involve plugging the upstream and downstream ends of the contaminated sewer sections and no longer using the aeration pond, oxidation basins, and associated outfall ditch. Monitoring would consist of periodic sampling and testing of soils adjacent to the contaminated facilities and of sediments near the outlet of the outfall ditch.

This technology provides more protection to the environment than the no action technology by restricting access to and abandoning the use of the contaminated facilities. However, this technology can also result in long-term risks to the environment and health due to continued migration of TCDD-contaminated materials from the facilities.

This technology was retained for further consideration.

Stabilization with Fixants. This technology involves leaving the contaminated material in place in the wastewater facilities and stabilizing it with fixants to reduce the potential for movement of the contaminated material, to minimize leaching into the groundwater, and to minimize contact by humans and wildlife. Possible fixants include inorganic (such as Portland cement and clays) and organic (such as hydrophobic cross-linked polymer-base gel) fixants. If an inorganic fixant is used, the volume of material would increase, thereby increasing the required storage capacity. Also, if stabilization with fixants is later determined to be an inadequate remedial method, more material would have to be treated and treatment of the material may be more difficult. Other concerns with fixants include possible deterioration of the fixant with subsequent leaching.

Thorough mixing of the fixant with the contaminated material is required. Because of the large surface area of the oxidation ponds, the fixant would be more easily incorporated after removing the sludge from ponds rather than mixing in place. Also a substantial cost savings is probable by first dewatering the sludges. Mixing the fixant in place with contaminants in the sewers is not possible.

Even though the fixants may be mixed in place with the contaminants in the aeration basin, outfall ditch, and abandoned wastewater treatment plant, mixing in place is not technically attractive for the sludges in the oxidation pond where the largest quality of the contaminated material in the wastewater facilities exist. Therefore, stabilization with fixants is eliminated from further consideration as a leave-in-place technology. However, stabilization with fixants may be developed as an intermediate technology associated with removal of the wastes and an ultimate waste management technology.

Stabilization with Sealants (capping). This technology involves leaving the contaminated materials in-situ and providing a physical barrier around the contaminated facilities to limit access to and migration of TCDD-contaminated material. The aeration pond and oxidation basins would be capped, the contaminated soils in the abandoned sludge drying bed and outfall ditch would be paved over, the sewer lines would be plugged, and the basins at the abandoned wastewater treatment plant would be covered. The sludges in the aeration pond and oxidation basins, which comprises the largest portion of contaminated material in the wastewater facilities, cannot support a cap without first being solidified. Since mixing the solidifying agent with the wastewater would be difficult to do without removing the sludges, this technology was eliminated from further consideration as an in-place technology.

In-place Biological Treatment. This technology involves seeding the contaminated facilities with microorganisms that can assimilate and degrade TCDD. Presently no micro-organisms have been shown to adequately perform this function on a full-scale basis. Therefore, in-place biological treatment was not retained for further consideration.

Removal

Removal of contaminated material from each of the contaminated facilities--the aeration pond and oxidation basins, the outfall ditch, the abandoned wastewater treatment plant, and the sewers--was considered.

Aeration Pond and Oxidation Basins. The technology considered for removing contaminated materials from the aeration pond and oxidation basins was to pump out the supernatant and sludges separately. It was assumed that the supernatant could be treated by water treatment processes designed to remove fine solids and then be discharged to a nearby waterway. The sludges would require more extensive processing due to the higher content of contaminated solids. Thus, the unit cost of subsequent remedial actions for the supernatant is lower than for the sludges. Although trying to remove the supernatant and sludges separately would require more control of the removal methods, this is not expected to substantially increase the total removal cost.

Removal of the contaminated liquids in the aeration pond and oxidation basins by pumping was retained for further development.

Outfall Ditch. Two removal technologies were considered for the outfall ditch--mechanical excavation and vacuum excavation. It was assumed that 12 in. of sediments/soil in the bottom of the outfall ditch would have to be removed.

Mechanical excavation would involve using equipment such as a backhoe or front-end loader. Dust control, if needed, would consist of periodically spraying the sediments. Excavation unit costs for mechanical excavation are less than one-eighth as much as for vacuum excavation.

Vacuum excavation would involve using a truck-mounted vacuum system with a HEPA filter to remove the sediments. This method offers tighter control of emissions of contaminated materials to the air. Overexcavation is expected to be less with a vacuum system than with mechanical excavation. Whether this reduction in overexcavation is enough to offset the higher cost for vacuum excavation cannot be determined without performance data for these methods for this particular site and without knowing the unit cost of subsequent handling methods.

Mechanical excavation was selected for further development because of its lower excavation cost, because it has been used successfully at other TCDD-contaminated sites, and since the outfall ditch is readily accessible.

Abandoned Wastewater Treatment Plant. The removal technology considered for the contaminated material in the abandoned wastewater treatment plant was to wash out the basins and to excavate the soils in the drying beds and outfall ditch. A jet-wash with a biodegradable cleaning solution is expected to adequately remove TCDD-contaminated material from the basin walls. Removal of the contaminated material in the abandoned wastewater treatment plant by washing the basins and excavating soil was retained for further development.

Sewers. Possible methods for removing contaminated material in the sewers include:

- o Mechanical cleaning
- o Hydraulic flushing
- o Complete removal of sewers and bedding material

The condition of the sewerlines, the characteristics of material in the sewers, and the function of the sewers are important considerations when selecting a method for removing contaminated material.

Of the cleaning technologies presented, the mechanical methods (power rodding and bucket cleaning) are most effective in removing obstacles such as roots, stones, grease, and sludges from sewers. Mechanical techniques have the advantage of removing heavy materials without using large quantities of water. These techniques also do not remove all of the loosened debris from the system. Mechanical cleaning must also be followed by hydraulic flushing.

Hydraulic flushing is most effective in cleaning sewers of loose or moderately accumulated sediments. However, by adding a cutterhead attachment, harder to remove obstacles, such as roots and grease, can also be removed. The main advantage of hydraulic flushing is that essentially all the solids are transported to a manhole where they can be removed with suction equipment. The hydraulic flush method generates large quantities of water. However, the sediments can be effectively removed from the water by dewatering.

Complete removal of sewers, manholes, and bedding material (if found to be contaminated) is the most intensive removal technology considered. The disadvantages of this technology include producing a larger amount of material that must be disposed of and/or treated, and, if the sewer line removed were active, then a new sewer line must be constructed. This technology may provide the most protection to the environment if the bedding material is contaminated, since a larger quantity of contaminated material is removed from the active ecosystem. Also, this technology may be the only possible means of removing contaminated material from sewer line sections that are grossly damaged.

Since mechanical cleaning must be succeeded with hydraulic flushing to adequately remove the solids in the sewer lines, and since a cutterhead attachment on a hydraulic flush unit can remove most, if not all, of the material in the sewers, hydraulic flushing was selected instead of mechanical cleaning as the primary cleaning technology. Complete removal of the sewer infrastructure and bedding material was also retained for further development since TCDD-contamination of the bedding material is unknown but possible.

ULTIMATE WASTE MANAGEMENT

The reader is referred to Section 3 for a discussion on ultimate waste management technologies.

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Section 5
DEVELOPMENT OF REMEDIAL ALTERNATIVES FOR THE WATERWAYS AND THE FLOOD PLAIN

The remedial technologies retained for the waterways and flood plains, shown in Figure 5-1, are assembled into remedial alternatives and developed in this section. Waste handling technologies are also described in this section. Figure 5-2 indicates the primary waste management steps, or technologies, involved with each of the seven alternatives that were developed for the waterways and flood plain:

- No action
- Restrict access and monitor migration
- In-place containment
- Local incineration
- Nonlocal incineration
- Local storage
- Nonlocal storage in RCRA facility

The areas of remediation assumed for developing the design criteria were shown in Figure 2-7 and discussed in Section 2.

The rest of this section further discusses the technologies. A remedial alternative may contain only one technology (see Figure 5-2).

MANAGEMENT OF MIGRATION--LEAVE-IN-PLACE

The three leave-in-place alternatives that were retained for further consideration--no action, restrict access and monitor migration, and in-place containment--are discussed below.

NO ACTION

The no action alternative consists of taking no action to control the migration of TCDD-contaminated material, to reduce exposure to TCDD, or to monitor the extent of contamination.

RESTRICT ACCESS AND MONITOR MIGRATION

The design criteria and assumptions for the restrict access and monitor migration alternative are summarized in Table 5-1.

Access to the contaminated waterways and flood plain would be restricted by installing a 6-foot high, chain-link fence with barbed-wire strands on top along both sides of the waterway, outside of the identified contaminated rear-channel strips. To construct the fence, access roads would have to be built. To help assure that the access roads are not built in unacceptably TCDD-contaminated areas, samples collected

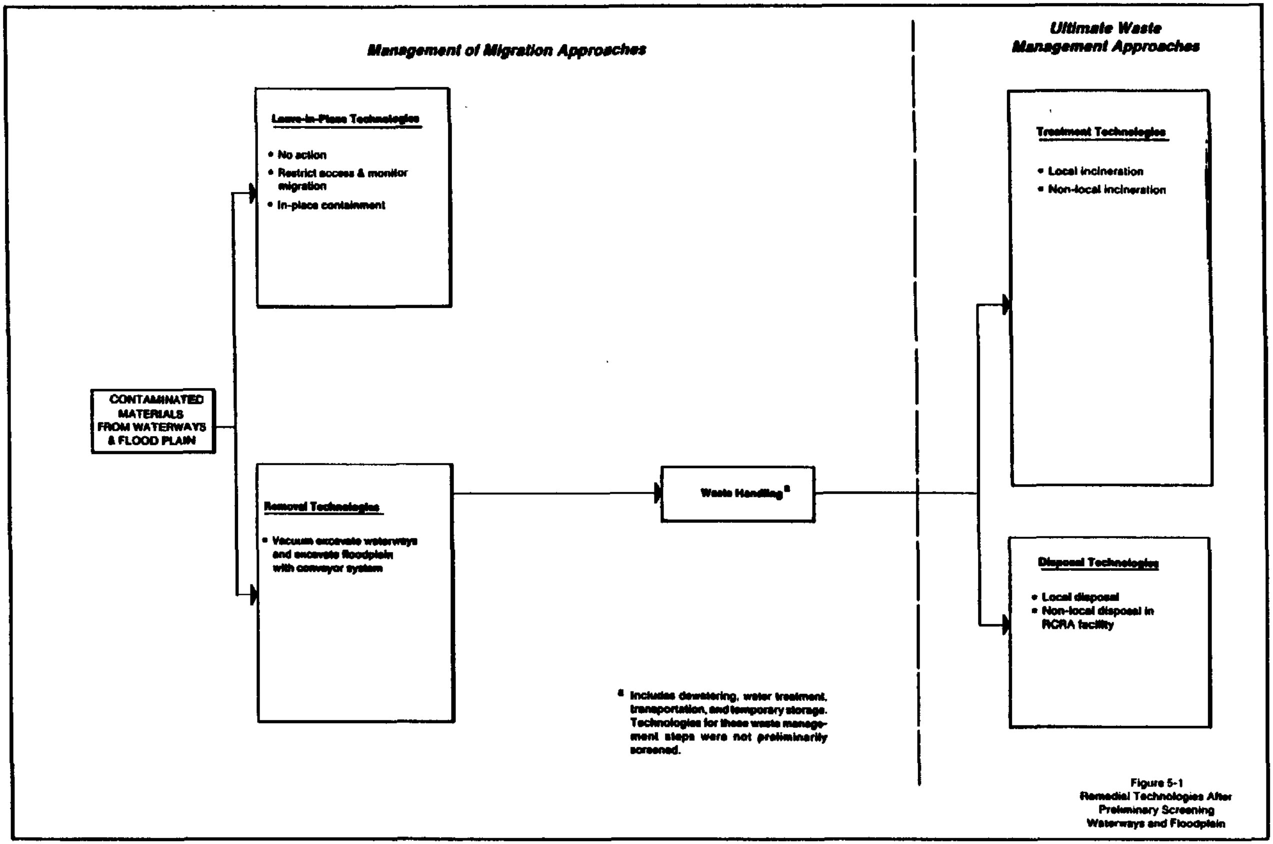

Figure 5-1
Remedial Technologies After
Preliminary Screening
Waterways and Floodplain

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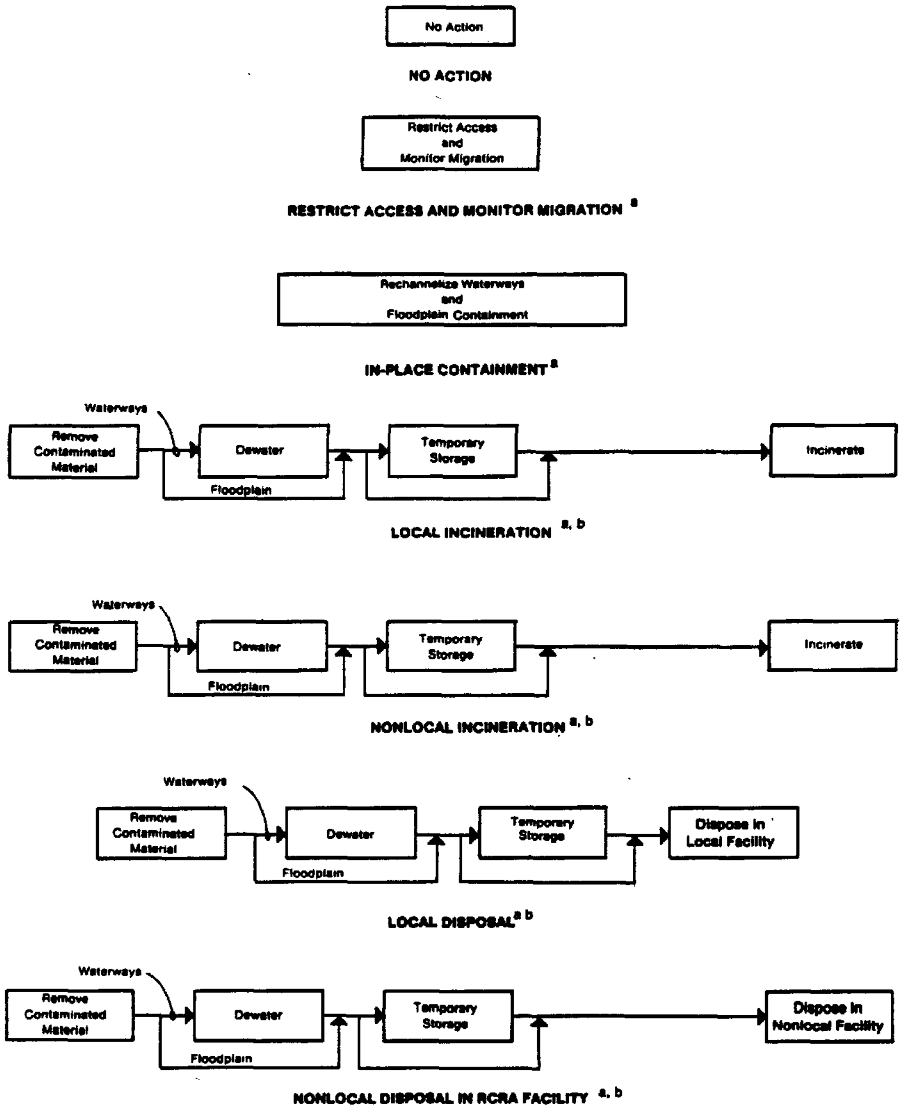

[a] These alternatives include a mobile water treatment facility.
[b] These alternatives include a fixed water treatment facility.

Figure 5-2
Waste Management Steps for Remedial Alternatives
Waterways and Floodplain

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Table 5-1

DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS--
RESTRICT ACCESS AND MONITOR MIGRATION ALTERNATIVE
FOR WATERWAYS AND THE FLOOD PLAIN

EXTENT OF REMEDIATION[a]	
Rocky Branch, ft	3,700
Bayou Meto, ft	6,450
SITE PREPARATION	
TCDD testing, number of samples	12
Clearing, acres	12
New Access roads[b], miles	4.5
Existing roads to be upgraded, miles	1.8
REMEDIATION ACTION	
Fence, ft	
Rocky Branch	7,400
Bayou Meto	12,900
TOTAL	20,300
Groundwater Monitoring	Extent of groundwater monitoring cannot be estimated without additional hydrogeologic information.
Sediment/Soil Samples	
Number of samples per testing occurrence	15
Frequency of testing	biannually
Duration of testing	indefinitely
RESTORATION	Minimal--roads will be left in place for future inspection and maintenance of fencing.

[a]See Figure 2-7.
[b]Fifteen-ft-wide roads with 6 in. of gravel on 1 foot of compacted imported soil was assumed to be adequate.

NOTE: Alternative generally assumes that ground is sufficiently stable to support construction, maintenance, and monitoring activities.

in. = inches, ft = feet.

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at about every 2,000 ft along the proposed access roads would be tested for TCDD. The access roads would remain in place to provide access for future inspection and maintenance of the fence. Access would be further restricted by increasing public awareness of the hazards associated with the contaminated areas, by posting signs, and by passing ordinances prohibiting trespassing of fenced areas.

Future monitoring would consist of sampling and testing for TCDD in the sediment and soil in the streams and flood plain. Monitoring wells would also be installed to detect movement, if any, of contaminated sediments and dissolved organics in the groundwater. Sampling sites would include upstream and downstream points from where contamination is currently thought to exist in the waterways and sites adjacent to the fenced contaminated flood plain area. The necessary hydrogeologic information for determining the number and location of the groundwater monitoring sites is unavailable at this time. Therefore, as part of this alternative, a hydrogeologic study would have to be conducted prior to selecting a monitoring program.

IN-PLACE CONTAINMENT

The in-place containment alternative retained for further development consists of filling the existing waterway channels with soil obtained from excavating new waterway channels parallel to the existing channels and placing geotextile and soil on top of the contaminated flood plain. The assumptions and design criteria for this alternative are summarized in Table 5-2.

When the identified waterway sections with assumed TCDD levels greater than 1 ppb are filled, most of the near-bank areas would not be covered because:

1. These areas will no longer be immediately adjacent waterway channels

2. These areas do not lie within residential or agricultural areas

3. The TCDD action level in these flood plains will now be 5 ppb

The exception to this is the land along the channels that lie within agricultural and residential zones and have TCDD levels greater than 1 ppb. Such land exists along the northern section of Rocky Branch.

Rechannelization

Site preparation activities include clearing a pathway adjacent to the existing channel for access roads and for

Table 5-2
DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS--
IN-PLACE CONTAINMENT ALTERNATIVE--
FOR WATERWAYS AND THE FLOOD PLAIN

EXTENT OF REMEDIATION	
Rocky Branch, ft	3,700
Bayou Meto, ft	6,450
Flood plain, ac	10
SITE PREPARATION	
TCDD testing, number of samples	8
Clearing[a], ac	38
New Access roads[b], miles	2.5
Existing roads to be upgraded, miles	1.8
REMEDIATION ACTION	
In-place excavation volume of new channel[c], yd^3	
Rocky Branch	27,400
Bayou Meto	78,300
TOTAL	105,700
Placement of geotextile in flood plain, ac	10
Placement of topsoil in flood plain	
Thickness, in.	12
Area, ac	10
Flood control berm	
Length, ft	2,100
Volume, yd^3	35,500
RESTORATION	
Removal and disposal of roadway material, yd^3	4,300
Area of seeding, ac	36
Area of reforestation, ac	26
Number of trees per acre	440
MAINTENANCE REQUIREMENTS	
Percent of flood plain geotextile and topsoil replaced annually	7
MONITORING	
Groundwater monitoring	Extent of groundwater monitoring cannot be determined without additional hydrogeologic information.
Sediment/soil samples	
Number of samples per testing occurrence	15
Frequency of testing	biannually
Duration of testing	indefinitely

[a]Assumes an average clearing width of 70 ft along Rocky Branch and 140 feet along Bayou Meto plus 1.3 ac for access roads to waterways and 10 ac in the flood plain.
[b]Fifteen-ft-wide roads with 6 in. of gravel on 1 ft of compacted imported soil was assumed to be adequate.
[c]Preliminary estimate based on channel dimensions recorded during remedial investigation.

NOTE: Alternative generally assumes that soil stability is sufficient for construction activities.

ac = acre.

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construction/excavation activities, constructing temporary gravel access roads to and along the channels, and providing decontamination facilities. To help assure that the access roads are not constructed on unacceptably TCDD-contaminated areas, samples collected at about 2,000-ft intervals along the proposed access routes would be tested for TCDD.

After the site is prepared, a parallel channel would be excavated in areas with TCDD levels less than 1 ppb. The new channel dimensions were assumed to be the same as the old channel dimensions. The excavated soil would be temporarily stockpiled adjacent to the existing stream until the new channel is entirely excavated. After the channel section is excavated, the flow would be diverted from the old channel section to the new channel section, and the old channel section would be filled with the stockpiled soil. The stockpiled soil would be carefully placed in the old channel, thereby minimizing the disturbance of bottom sediments and displacing most of the water.

The water would flow over a "dam" consisting of sheet piling at the downstream end, thereby reducing the amount of sediment transport downstream. Vegetation in the abandoned channel sections would be buried along with the contaminated sediments. The soil in the abandoned channel sections would be lightly compacted. Soil in the abandoned channel is expected to be unstable and unable to support heavy equipment for several years due to its high moisture content from water that would not be displaced downstream.

A new channel would not be built under roadways and railroads. In these locations, the contaminated material would be removed from the existing channel and placed in upstream or downstream channel sections that are to be abandoned. The new channel would tie into the dredged, existing channel sections at these crossings.

Site restoration activities include removing the temporary gravel access roads, disposing of the roadway material in the abandoned channel, reseeding, and planting trees.

Long-term monitoring requirements would consist of groundwater sampling and sediment/soil sampling in the new channel. The necessary hydrogeologic information for determining the groundwater monitoring requirements is unavailable at this time. A hydrogeologic investigation would be required as part of this alternative.

<u>Flood Plain Containment</u>

Flood plain containment would consist of placing geotextile and about 12 in. of imported topsoil on top of the contaminated soil.

Site preparation activities include clearing a pathway to and around the contaminated areas, constructing gravel roads, and providing decontamination facilities. To help assure that the access roads are not constructed on unacceptably TCDD-contaminated areas, samples collected at about 2,000-ft intervals along the proposed access routes would be tested for TCDD. All vegetation, except trees, would be removed, mulched, and placed on top of the contaminated soil.

The geotextile would be placed on top of the contaminated soil, around the trees. The main purpose of the geotextile is to provide a demarkation between the contaminated soil and the imported, noncontaminated topsoil. When the geotextile becomes visible in the future, this will indicate that additional topsoil is needed. Also, if additional action is desired with the contaminated soil later, the geotextile would indicate where the contaminated soil begins. The geotextile, usually made of polyester or polypropylene, is nonbiodegradable and is not expected to be attacked by chemicals in the soil. The geotextile would be treated to reduce sensitivity to ultraviolet light. The geotextile may be penetrated by borrowing animals and roots. The geotextile would have some porosity to allow for passage of air and water.

Imported topsoil would be placed on the geotextile and would be seeded. The topsoil and geotextile would require periodic maintenance. An earthen berm would be placed around the contaminated areas to reduce the amount of soil erosion.

MANAGEMENT OF MIGRATION--REMOVE MATERIAL

This alternative includes vacuum excavation of the waterways and excavation of the flood plain via a conveyor system.

VACUUM EXCAVATION OF WATERWAYS

The design criteria and assumptions used in developing this alternative are given in Table 5-3.

Roads would have to be constructed to and along the waterways to provide access for excavation and hauling equipment. Areas adjacent to the waterways where construction activities would occur would have to be tested to determine whether the TCDD levels in these areas are acceptable. If the TCDD levels in these areas are unacceptable, the soils would have to be removed prior to starting excavation activities for the waterways. It was assumed that one sample would be taken every 2,000 ft along the proposed access roads in the 5-year (yr) flood plain.

Table 5-3
DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS--
EXCAVATION OF WATERWAYS AND FLOOD PLAIN

EXTENT OF REMEDIATION	
Rocky Branch	
Length of excavation, ft	3,700
Depth of excavation, in.	4-12
Type of material	silt and clay
In-place volume of contaminated material, yd^3	
In-stream sediments	1,900
Bank sediments and soils	3,800
Overexcavated material, yd^3	300
Wet density, lb per ft^3	
In-stream sediments	100
Bank sediments and soils	110
Moisture content, %	
In-stream sediments	100
Bank sediments and soils	40
Bayou Meto	
Length of excavation, ft	6,450
Depth of excavation, in.	6-15
Type of material	fine-grained sand, silt, and clays
In-place volume of contaminated material, yd^3	
In-stream sediments	10,300
Bank sediments and soils	7,500
Overexcavated material, yd^3	900
Wet density, lb per ft^3	
In-stream sediments	100
Bank sediments and soils	110
Moisture content, %	
In-stream sediments	100
Bank sediments and soils	40
Flood Plain (near-channel)	
Area, ac	23
Average depth, in.	12
In-place volume of contaminated material, yd^3	37,600
Overexcavated material, yd^3	1,900
Wet Density, lb per ft^3	125
Moisture content, %	15
SITE PREPARATION	
TCDD-testing, number of samples	
Waterways	15
Flood plain	150
Clearing, acres	26
New access roads[a], miles	5
Existing roads to be upgraded, miles	1.8
REMEDIATION ACTION	
Method of Excavation	
In-stream sediments	Vacuum excavation in isolated, de-watered sections
Bank sediments and soils	Vacuum excavation supplemented with rototilling where required
Flood plain	Conveyor system

Table 5-3
(continued)

Rate of excavation, yd^3 per day	
per truck	
Vacuum system	9
Conveyor system	200
Number of Trucks	
Vacuum	3
Conveyor	2
Overexcavation, %	5
Isolated Channel Sections for Excavation	
<u>Rocky Branch</u>	
Average length, ft	1,200
Average width, ft	30
Number of isolated sections	3
Average surface area of sheet piling per isolated section, ft^2	800
Average time each section is isolated[b], days	25
<u>Diversion System</u>	
Pipe material	12" PVC
Pipe length, ft	1,800
Pump capacity, gpm	2,800
Pump head, ft	60
<u>Bayou Meto</u>	
Average length, ft	1,600
Width, ft	16 to 30
Number of isolated sections	8
Average surface area of sheet piling per isolated section, ft^2	16,000
Average time each section is isolated[b], days	50
Dewatering	
<u>Rocky Branch</u>	
Average volume of water initially in each isolated section, MG	0.30
Continuous dewatering rate, mgd	0.24
Total volume of water removed, MG	19
<u>Bayou Meto</u>	
Average volume of water initially in each isolated section, MG	3.0
Continuous dewatering rate, mgd	0.4
Total volume of water removed, MG	190
<u>Dewatering System</u>	
Length of pipeline system, ft	13,000
HDPE pipeline diameter, in.	6
Steel pipeline diameter, in.	10
Pump capacity:	
<u>Rocky Branch</u>	
Flow, mgd	0.24
Total dynamic head, ft	30
Number of pumps	2
Generator capacity, horsepower	2

Table 5-3
(continued)

Bayou Meto	
Flow, mgd	0.4
Total dynamic head, ft	210
Number of pumps	2
Generator capacity, horsepower	20
Post-excavation TCDD Testing	
Number of samples per isolated section	5
Number of samples per ac of flood plain	5
Total number of tests	170
RESTORATION	
Volume of roadway material to be removed and disposed, yd^3	9,000
Hauling and compacting topsoil for flood plain, yd^3	39,500
Area of seeding, ac	26
Area of reforestation, ac	9
No. of trees per acre	440
MONITORING	
Groundwater	None
Sediments	5 samples each yr for 5 yr

[a]Fifteen-ft wide roads with 6 in. of gravel on 1 ft. of compacted imported soil was assumed to be adequate.
[b]Does not include estimated time for mobilization/demobilization which is estimated to be 10 days for Rocky Branch and 20 days for Bayou Meto.

NOTES: Alternatives generally assume that soil stability is sufficient for construction activities.

MG = million gallons; mgd = million gallons per day; lb = pound; gpm = gallon per minute; ft^3 = cubic foot; ft^2 = square foot.

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Existing roads used by the construction and hauling equipment were assumed to require upgrading and periodic maintenance. Mobile decontamination facilities for both equipment and personnel would also be needed.

Excavation in an isolated, dewatered channel is recommended so that debris can be easily removed prior to excavation and the amount of contaminated sediment that disperses downstream can be reduced. Sheet piling would be used to isolate sections of the stream. Sheet piling is more expensive than earthen berms, but installation of the sheet piling would disturb channel debris and sediments to a lesser extent. Earthen berms would also occupy an unreasonably large portion of the channel in some narrow sections. The soil used for the berms would probably be considered TCDD-contaminated and would thereby increase the total volume of contaminated material that must be ultimately disposed of or treated. The level of difficulty of using sheet piling equipment at this site cannot be determined at this time due to insufficient site information. The sheet piling would have weirs to allow flow to enter the isolated section during extreme storm events to reduce flooding of the adjacent banks.

On the Rocky Branch, the entire width of the channel would be isolated, and the flow would be diverted with a pump and pipeline. This system is expected to be adequate since visual observation of the stream during the summer indicated that the flow in Rocky Branch is low or nonobservable. The diverted water would come from the upstream noncontaminated or previously cleaned channel and, therefore, would not require treatment.

Only about half of the width of Bayou Meto would be isolated at a time since a large pumping and piping system would be needed to divert the flow if the entire width were isolated. After a channel section has been isolated with sheet piling, the isolated section would be dewatered. The water would be conveyed to and treated at a water treatment plant to be built near the oxidation ponds. Water treatment is described under "Waste Handling." Once dewatered, a perimeter drainage ditch would be installed to intercept seepage from the sheet piling and banks, flow from under the sheet piling, and rainwater. Water intercepted by the ditch would drain by gravity to a sump from which it would be pumped to the water treatment plant, and then treated (see "Waste Handling") and discharged to Bayou Meto.

A pump and pipeline system would convey water removed from the isolated section to the proposed water treatment plant. The pipeline system would consist of a 6-in. high density polyethylene (HDPE) pipe encased in steel pipe to contain possible leakage from pipe joints. The pipe would be laid directly on the ground parallel to the access road except at road or railroad crossings. At these crossings, the pipe would generally either be secured on dry bank or be suspended below the bridge. One underground pipeline crossing using jacked pipe was assumed at the Redmond Road/Highway 167 intersection. When use of the pipe has terminated, it was assumed that the pipe would be cleaned, delisted, and salvaged for future use.

Prior to excavating, debris larger than the diameter of the vacuum tube would be removed from the channel. Garbage and vegetative debris are in both waterways. It was assumed that this debris would be removed manually. It is not expected that a jet-water wash would adequately remove TCDD-contaminated particles entrained in wood. Therefore, it was assumed that this material would be disposed of with the contaminated sediment. Most of the debris was assumed to be vegetative-type. It was assumed that trees and stumps in the channel would be left in place. The debris would be hauled away in dump trucks to temporary storage.

The excavated material would be directly loaded into the vacuum trucks. Each truck was assumed to be able to hold 13 yd^3 of loose material.

After a section is dredged, the remaining stream bed material would be tested for TCDD. It was assumed that five samples would be taken for each isolated section. If the TCDD levels are unacceptable, additional stream bed material would be removed. If the TCDD levels are acceptable, which was assumed, then excavating activities would move downstream.

Stream restoration would consist of removing sheet piling and allowing flow to return to the channel. It was assumed that the stream bed would not be regraded. When access roads are no longer needed, the roadway material would be removed and disposed of in a local sanitary landfill. The land would be reseeded and reforested.

Hauling equipment would be decontaminated before leaving the site. Equipment normally left onsite would be decontaminated whenever the equipment left the contaminated area or when activities would be completed. Decontamination would consist of jet-wash cleaning. The wastewater produced from the decontamination activities would be treated onsite in a mobile treatment unit (see "Water Treatment").

Long-term monitoring was assumed to consist of five annual sediment TCDD tests for 5 yr. It was assumed that the post-excavation TCDD levels would be acceptable.

EXCAVATION OF THE FLOOD PLAIN

Table 5-3 lists the general assumptions and design criteria for excavating the flood plain.

The flood plain areas assumed to be remediated lie immediately adjacent to the channel sections to be remediated. Prior to excavating, additional TCDD testing would be conducted to better define the areal extent and depth of contamination. Since the proposed access roads for remediating the waterways lie partially within flood plain areas to be remediated, the flood plain would be remediated prior to remediating the waterways.

The proposed method for removing soil from the flood plain is a conveyor method, which is a modified vacuum system. The conveyor system has a reach of about 200 ft. The access roads used for excavating the waterways are expected to be sufficient for providing access of conveyor system to the flood plain.

The conveyor system would work around trees and stumps. Other vegetation within the depth of excavation would be removed and handled as TCDD-contaminated material. The volume of vegetation removed in the flood plain was assumed to be insignificant relative to the volume of soil removal. A tank/sprinkler system would be used to control dust emissions during excavation.

Mobile decontamination facilities and an associated mobile water treatment plant would be provided to decontaminate equipment prior to when it leaves the site and at the end of the excavation activities.

Post-excavation activities include additional TCDD-testing to help determine if the extent of excavation was adequate. Site restoration would also consist of removal and disposal of roadway material in a local sanitary landfill, backfilling the flood plain with imported topsoil to its original elevation, reseeding, and planting seedlings where deforestation for road construction has occurred.

No long-term monitoring is included under this alternative for the flood plain.

WASTE HANDLING

DEWATERING

The design criteria and assumptions used in developing the dewatering system for the waterway sediments are given in Table 5-4. It is assumed the flood plain sediments/soil would be at a 15-percent moisture content when collected and

Table 5-4
DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS
DEWATERING WATERWAY SEDIMENTS

Characteristics of Waterway Sediments	
In-stream sediments	
In-place volume, yd^3 (bank volume)	12,800
Wet density, lb per ft^3	100
Moisture content before dewatering, %	100
Moisture content after dewatering, %	10
Bank sediments and soils	
In-place volume, yd^3	11,900
Wet density, lb per ft^3	110
Moisture content before dewatering, %	40
Moisture content after dewatering, %	10
Dewatering Facility	
Dewatering method	Sediment wind-rows on concrete slab inside a greenhouse structure--evaporation and gravity drainage
Area required, ac	1
Location	Adjacent to oxidation ponds
Dewatering rate, yd^3 of nondewatered sediments per month	1,300
Leachate	
Design rate, gpm	2.8
Total design volume, MG	2.4
Site Restoration	
Removal and disposal of concrete slab, sand, and HDPE layer, yd^3	1,800
Removal of engineered fill, yd^3	23,500
Area of seeding and reforestation, acres	1
Number of trees per acre	440

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additional dewatering prior to ultimate waste management would not be necessary nor advantageous.

The sediment collected from the waterways would be dewatered prior to implementing an ultimate waste management alternative. Several methods for dewatering the sediments are available, including mechanical dewatering or sand drying beds however, the sediment dewatering system most applicable to the waterway sediments is a modification of standard dredged material dewatering methods.

The principal mechanisms for dewatering of sediments are evaporation and gravity drainage. The sediment dewatering system would consist of a 1-acre concrete slab underlain by a 30-mil HDPE liner, a permeable material (sand), and another 30-mil HDPE liner below the sand to protect against leaks. The dewatering facility would be constructed adjacent to the oxidation ponds on fill designed to keep the facilities 10 ft above the historically high groundwater level to avoid excessive hydrostatic pressures. The concrete slab and liner would be sloped to drain into a sump, where the water would be pumped to the treatment plant. A greenhouse structure with a heating and ventilation system and dust control system would be constructed over the concrete slab to protect the drying sediments from rainfall, to promote evaporation, and to help contain dust.

Prior to placing the sediments in the dewatering facility, large debris would be removed, and the sediments would be processed through size-reduction facilities. The sediments would then be placed in a 1-ft thick layer on the concrete slab. A small tractor with conventional farm implements would cut furrows in the direction of slope to promote gravity drainage by providing a free path for the water to travel. Gravity drainage is an important dewatering mechanism for very wet sediments; however, to obtain as dry a sediment as possible, evaporation would be the principal mechanism. To promote evaporation, the sediments would be mixed on a routine basis using a small tractor to expose wet materials to the air. It is assumed that through evaporation, the sediments will have a moisture content of 10 percent (dry solids basis) within 1 month of placement in the sediment drying facility.

The leachate would be collected and treated at the proposed water treatment plant also to be built near the oxidation ponds. (See "Water Treatment.")

After all the sediments are dewatered, the dewatering facility will be removed and the site restored to its original condition. It was assumed that a jet-water wash would adequately decontaminate the concrete slab and greenhouse structure. The concrete slab would be broken up and disposed of in a local landfill, whereas the greenhouse structure would be salvaged for future use. It was also assumed that the underlying sand and HDPE would be delisted and disposed of in a local landfill. The 1-acre site would then be regraded, reseeded, and planted with seedlings.

WATER TREATMENT

This section discusses the overall water treatment process assumed for development of remedial action alternatives. The proposed water treatment processes are the same for the remedial alternatives proposed for both the waterways and flood plain and the wastewater facilities. The water sources requiring treatment of the different remedial action alternatives for the waterway and flood plain are listed in Table 5-5. Table 5-6 shows the sizes of water treatment systems corresponding to remedial action alternatives.

The proposed treatment scheme for the main facility and the mobile facility is shown in Figure 5-3. The treatment processes consist of sequential removal of suspended solids at increasingly smaller particle sizes and a final treatment with carbon adsorption. Since TCDD is relatively hydrophobic and binds to organic matter and particulate surfaces, removal of suspended solids will remove TCDD from water. The final carbon adsorption step will provide surface contact to remove submicron TCDD contaminated particles and solubilized TCDD. Spent carbon would be handled as a RCRA waste. Regeneration or disposal of the spent carbon would be evaluated for its ultimate disposation.

The treatment sequence consists of: (1) addition of flocculants (aluminum or iron salts and/or polymers) to cause particles to coalesce, promoting more rapid settling, (2) primary clarification, where the flocculated particles are given sufficient time and surface area to settle out in a tank and are subsequently pumped to solids dewatering (refer to solids dewatering section), (3) mixed media filtration to remove particles down to a nominal 10-micron size, (4) successive cartridge filtration through 5, 1, and 0.1-micron filters, and (5) granular activated carbon adsorption beds. The first three treatment steps would be supplied in a packaged water treatment system.

Bench-scale testing would be required prior to selecting the treatment processes to determine the effectiveness and level of sequential particle removal needed to comply with surface discharge water requirements. The final effluent would require a state-issued National Pollution Discharge Elimination System (NPDES) permit to discharge to local surface waters.

The main water treatment plant would be constructed adjacent to the oxidation ponds on an engineered fill to raise the

Table 5-5
WASTE STREAMS TO REMEDIAL WATER TREATMENT PLANT
FOR REMEDIAL ALTERNATIVES FOR WATERWAYS AND THE FLOOD PLAIN

Remedial Action Alternative	Waste Streams
No Action	None
Restrict access and monitor migration	o Personnel and equipment decontamination washwater
In-place containment by rechannelization	o Personnel and equipment decontamination washwater
Local incineration[a]	o Personnel and equipment decontamination washwater
	o Water removed from existing waterway prior to and during sediment removal
	o Leachate from solidsdewatering
Nonlocal incineration[a]	o Personnel and equipment decontamination washwater
	o Water removed from existing waterway prior to and during sediment removal
	o Leachate from solids dewatering
Local disposal facility	o Personnel and equipment decontamination washwater
	o Water removed from existing waterway prior to and during sediment removal
	o Leachate from solids dewatering
	o Leachate from disposal facility
Nonlocal disposal in RCRA facility[b]	o Personnel and equipment decontamination washwater
	o Water removed from existing waterway prior to and during sediment removal
	o Leachate from solids dewatering

[a] Scrubber water treatment included with incinertion facility.
[b] Treatment of leachate would be provided by existing commercial facility.

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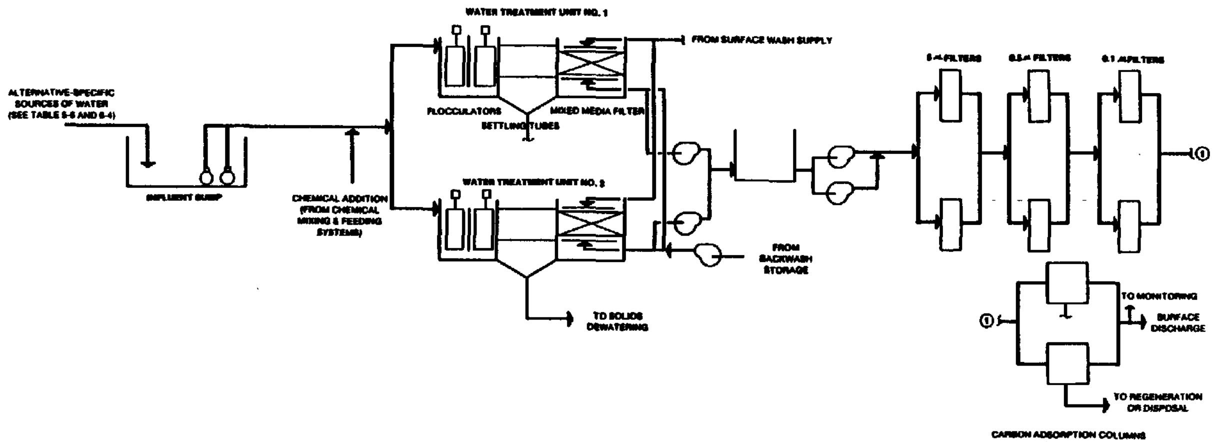

Figure 5-3
Conceptual Water Treatment System
For Removal of TCDD Contaminated Solids

facilities 10 feet above the historically high groundwater level to avoid undesirable hydrostatic forces and flooding of the structures.

Table 5-6
CAPACITY OF WATERWAYS AND FLOOD PLAIN TREATMENT SYSTEMS

Remedial Action Alternative	Size of New Water Treatment Systems: Main Facility (mgd)	Size of New Water Treatment Systems: Mobile Facility for Recirculation of Decontamination Washwater (gpm)
No Action	--	--
Restrict Access and Monitor Migration	--	10
In-place Containment by Rechannelization	--	50
Local incineration	2	50
Nonlocal incineration	2	50
Local disposal facility	2	50
Nonlocal disposal in RCRA facility	2	50

Site restoration would consist of salvaging the water treatment equipment, disposing construction materials in a local landfill after delisting, removing the engineered fill, regrading, reseeding, and reforesting.

SOLIDIFICATION

Solidification is not proposed for the contaminated materials from the waterways and flood plain. Dewatered sediment from the waterways at a 10-percent moisture content and soils from the flood plain at the assumed 15-percent moisture content were assumed not to require solidification prior to hauling or storing.

TEMPORARY STORAGE

Temporary storage is expected to be needed for all the alternatives that include removing the contaminated materials. The rate at which the material can be incinerated or placed in a storage facility is not likely to be the same rate at which the material is dewatered or excavated. Two 100- by 200-ft container facilities would be required for temporary storage of contaminated soils/sediments from the waterways and flood plains. One 40- by 40-ft container facility would be required for temporary storage of debris from the waterways and flood plains. The facility would be built on an engineered soil fill to raise the structure 10 ft above the historically high groundwater level.

Each container facility would consist of a containment base, the stacked containers, and a containment enclosure. Based on analyses for previous feasibility studies, 2-yd^3 semibulk bags would be used for the containers. Vegetation, trees, and other organic debris would need to be mulched before placement in semibulk sacks.

Federal and state regulations allow a container facility to have a single-liner base with a capacity sufficient to contain the volume of the largest container or 10 percent of the total volume, whichever is greater. (Note that primary containment is produced by the containers themselves.) The concrete slab base with an impervious layer was selected over a synthetic liner due to its ability to withstand concentrated loads and its lower disposal cost.

The base would consist of an impermeable layer of geotextile cover, a reinforced concrete slab, and a layer of granular fill. The granular fill beneath the concrete slab provides a construction working surface on which to tie reinforcing steel and pour the slab without disturbing the prepared foundation soils. The base also features a low (2- to 3-ft-high) reinforced concrete wall around the perimeter of the storage area. This wall may serve as a strip footing for the walls of a building enclosure and as an anchor curb for the primary liner. The slab and inside face of the wall would have an impermeable layer.

Two different container facilities enclosures were considered: a steel building and a synthetic membrane enclosure. Figure 5-4 shows an example of the steel building option that was selected for detailed development.

The primary technical advantage of a steel building relative to a synthetic cover is that container inspection is easier within a building due to the presence of electric lighting and space above and around the perimeter of the storage area. However, depending on the stacking configuration, only a portion of the containers can readily be inspected. With a synthetic cover, inspection of the containers would require the inclusion of access doors built into the cover, or unfastening and removing the cover, then refastening it. If frequent (for example, monthly) container inspection is required during the interim storage period, then a building may be the preferred enclosure. If inspection is not required frequently, then a synthetic cover may be preferred due to its lower maintenance cost.

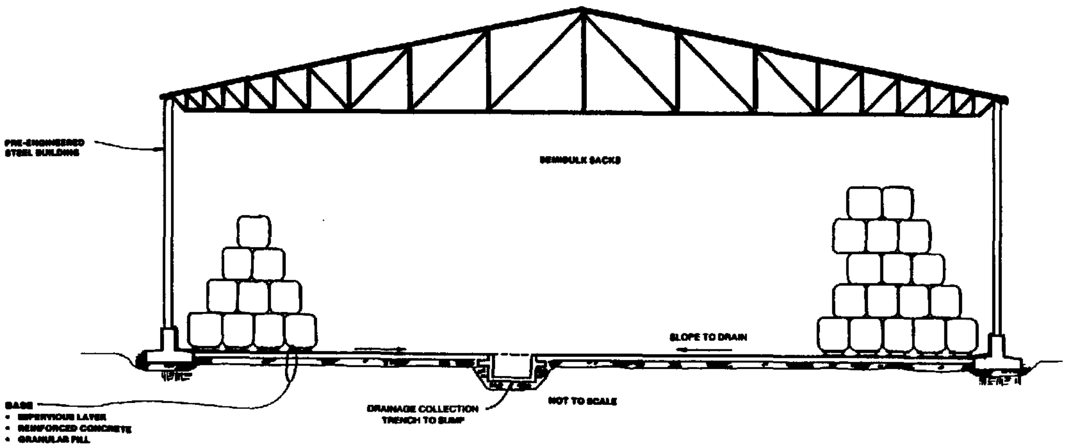

Figure 5-4
Temporary Storage Facility

After the sediments, soils, and debris have been hauled to the ultimate waste management site, the temporary storage facilities would be removed. Construction materials were assumed to be decontaminated via a jet-water wash and then disposed of in a local landfill. The wash water would be treated at the mobile treatment facility. The engineered fill would be removed and the site regraded, reseeded, and reforested.

ULTIMATE WASTE MANAGEMENT--TREATMENT

This discussion pertains to both the waterways and flood plain, and the wastewater facilities. The quantity of material from the wastewater facilities assumed to be incinerated is given in Section 6. 009735

Two thermal treatment alternatives were developed; the primary difference between the two alternatives is the treatment location. For the local incineration alternative, the contaminated materials would be treated near the existing wastewater facilities using a transportable incinerator. The design criteria for this alternative is given in Table 5-7. The layout of the associated waste handling is shown in Figure 5-5. For the remote incineration alternative, contaminated materials would be transported to an existing offsite thermal treatment unit.

The following background information is presented to provide background for, and a better understanding of, the specific incineration processes selected for the alternatives. The background discussions are broken into two parts:

- An overview of the thermal treatment process
- A discussion of an available technology suited to treat the contaminated materials from the Vertac Offsite

THERMAL TREATMENT OF TCDD-CONTAMINATED SOIL: AN OVERVIEW

Material Handling and Preparation

As currently conceived, the incinerator feed would primarily be contaminated sediments and soils with a mixture of rocks, roots, and other debris from the waterways and flood plain. The waterway sediments would be dewatered prior to feeding to the incinerator. The contaminated materials would be placed in size-reduction equipment as the first step of thermal treatment. Size reduction facilitates material handling,

Table 5-7
DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS
LOCAL INCINERATION--WATERWAYS AND THE FLOOD PLAIN,
AND WASTEWATER FACILITIES

Dewatered waterway sediments, tons	23,400
Flood plain soils, tons	63,400
Debris, tons	1,700
SUBTOTAL, tons	88,500
Material from wastewater facilities[a], tons	33,500 or 42,200
TOTAL, tons	122,000 or 131,000
Incineration Facility	
Incinerator	Portable rotary kiln
Location	Adjacent to oxidation ponds
Area required, acres	1
Incineration rate, tons/day	64
Ash production from sediments, tons/day	52
Ash production from sludges, tons/day	8
Site Restoration	
Remove, decontaminate, and reuse auxiliary buildings	--
Remove and dispose concrete slabs in a municipal landfill	--
Area of seeding and reforestation, acres	1
Number of trees per acre	440

[a]See Table 6-7 for breakdown of material to be incinerated from wastewater facilities.

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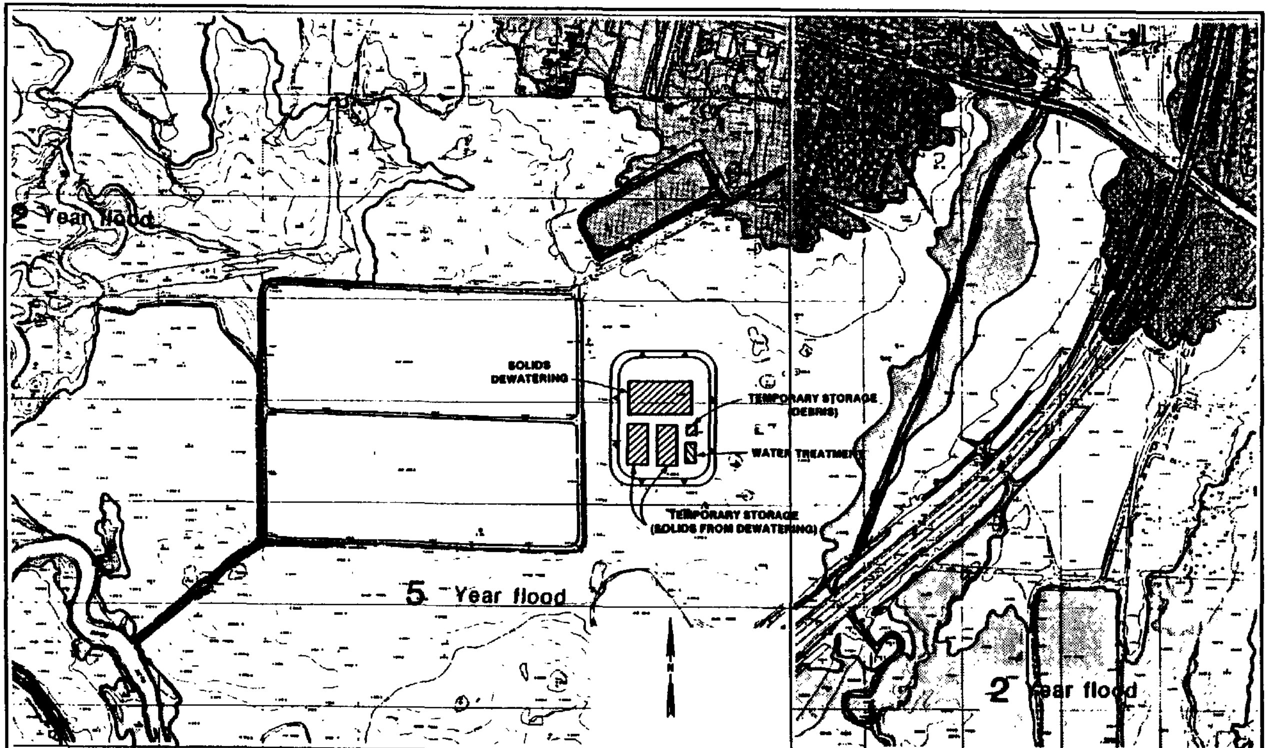

Figure 5-5
Layout of Waste Handling Facilities
Waterways & Floodplain
Incineration or Non-local Disposal

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provides for uniform heat transfer, and helps avoid incinerator damage. This could be accomplished through either a wet or dry process. A wet process appears applicable to the Vertac facility due to the high moisture content of the sediments and sludges.

The wet process would slurry the heterogeneous mixture in a tumbling drum scrubber to separate fine from coarse material. Next, a series of screening devices would classify the coarse material, and a three-stage crushing process would reduce the coarse material to a suitable size (such as 28 mesh). The fine soil slurry would be dewatered, then mixed with the crushed material in a pugmill. The water would be treated to remove TCDD-contaminated particles. A shredder would process large fibrous materials such as tree roots that might be removed from the sites.

A testing program could be used to determine the need for incinerating rocks and other large debris. If testing showed this material to be relatively free of TCDD (less than 1 ppb) after the soil was washed from the surface, and eligible for delisting, it would be washed and disposed of without treatment. If, on the other hand, TCDD is shown to have adhered to the surface or to have migrated into pores, the material would need to be crushed and incinerated. It was assumed that the amount of large material that would be delisted instead of incinerated was insignificant and would not have a significant effect on the total cost.

Incineration

Incineration of TCDD-contaminated materials typically is a two-step process. The first step occurs in a primary combustion chamber at about 1,600° to 1,800°F, where combustible solids are burned and TCDD is vaporized. Solids usually remain in the primary chamber for at least 30 minutes (min) and then are removed from the incinerator and quenched.

The second step occurs in a secondary combustion chamber or afterburner, where vaporized TCDD is destroyed by the combined conditions of 2,200° to 2,300°F, 2-second minimum residence time, and 3-percent minimum excess oxygen. Wet scrubbers are used to quench the hot exhaust gases and to remove entrained particulate matter from the gas stream. Heat recovery equipment may be used to reduce quench water requirements and to provide motive power for some incineration equipment.

Handling of Treated Soil

For every 10 lb of soil incinerated, roughly 8 lb of treated soil would remain based on an assumed ash content of 80 percent. For every 10 lb (as solids) of sludge incinerated, roughly 5 lb of ash would remain based on an assumed ash content of 50 percent. The reduction in soil volume would not be significant because the treated soil would have a lower density. After incineration, the treated soil and ash would be stored and then analyzed for TCDD. If the treated soil and ash is delisted at that time, it could be placed in a solid waste landfill. If it has not been delisted, the residue would be disposed of at an offsite RCRA landfill. It was assumed that the treated soil and ash would be delisted. If the ash could not be delisted, incineration would not be a viable technology. The scrubber water and ash quench water blowdown would undergo treatment and filtering to remove solids, while particulates captured by scrubber water would be concentrated and handled with the treated soil, or returned to the incinerator feed. Filtered scrubber and blowdown water would be analyzed for TCDD prior to discharge. If the analyses show TCDD to be present, the scrubber and blowdown water would require additional treatment.

CURRENTLY AVAILABLE TECHNOLOGY

Many existing methods could be used for the thermal treatment of TCDD-contaminated materials. However, many are either unsuitable for treatment of contaminated soil or have not yet been developed to a point where they can be used on a commercial scale. Selection of a treatment method would depend not only on these technical concerns but also on economic factors as well. The remainder of this report will assume that rotary kiln incineration (RKI) would be the selected technology if thermal treatment is used to deal with the Vertac contaminated materials. The reasons for this assumption are twofold:

- First, the RKI process is the best developed incineration technology, in terms of experience with waste incineration, TCDD destruction, and soil treatment in general, and TCDD soil treatment specifically.

- Second, commercial-scale stationary and transportable RKI units already exist, which is not yet the case for the other processes such as electric infrared incinerators and advanced electric reactors.

Rotary Kiln Incinerator (RKI) Technical Description

An RKI consists of a refractory-lined cylinder that is inclined a few degrees from the horizontal and rotates at a low speed. Figure 5-6 presents a flow diagram of an RKI. Ram feeders force solid waste into the upper end of the kiln; the drum rotation and incline cause the burning solids to migrate to the lower end of the kiln, where the ash is discharged. The kiln interior is fired directly by gas or liquid fuel burners

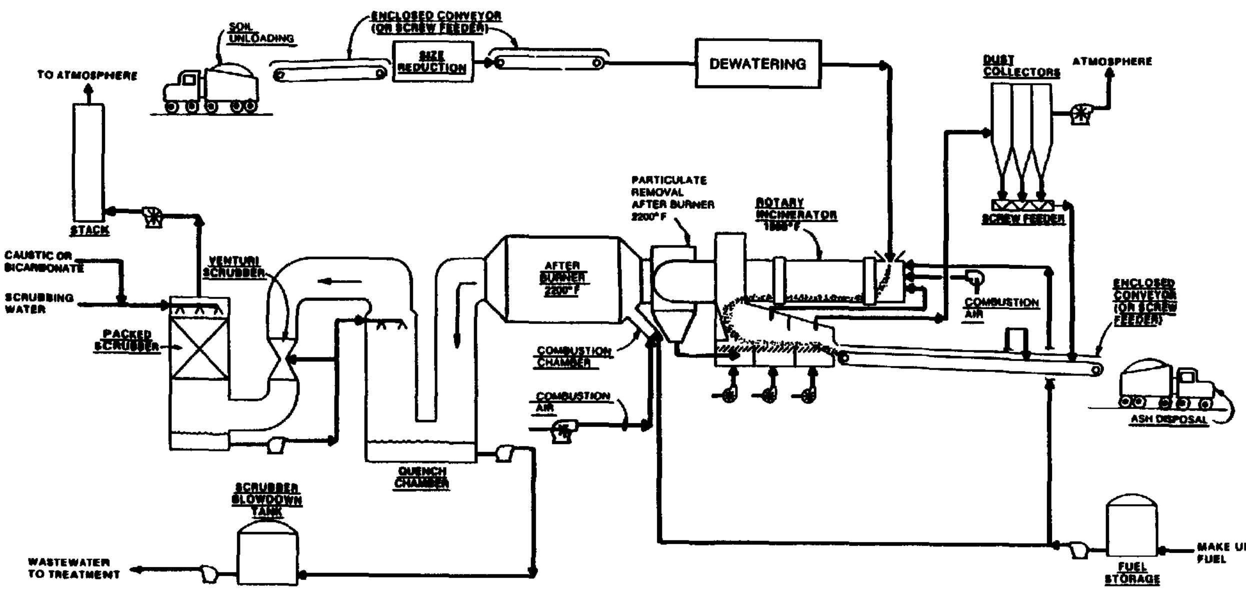

Figure 5-6
Conceptual Flow Diagram
For Rotary Kiln Soil Incineration

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to maintain the desired temperatures inside. Combustion air is also introduced as required to burn the fuel and any combustible solids in the waste feed.

When used to treat TCDD-contaminated soil, the rotary kiln itself would burn combustible material in the soil feed (such as plant matter and trash) and vaporize the TCDD. To do this, the kiln would operate in the range of 1,600° to 1,800°F, with a minimum solids residence time of 30 min. Higher temperatures in the kiln would be undesirable because the soil feed would tend to fuse to itself and to the kiln walls in a process called "slagging."

The combustion gases containing vaporized TCDD would next be routed through particulate removal equipment to a separately fired afterburner. Here, the TCDD would be destroyed at conditions of 2,200° to 2,300°F, 3-percent minimum excess oxygen, and 2-second minimum gas residence time. The hot combustion gases would exit the afterburner through scrubbers, which would cool it and clean it of remaining particulates before discharging it through the stack. Stack gas sampling would regularly test for residual TCDD.

RKI Operating Experience. The rotary kiln probably is the most widely used type of hazardous waste incinerator in the United States today. The kiln has been used extensively to incinerate PCB's and is the most highly developed of those types of incinerators used for soils contaminated by TCDD. However, commercial use of the rotary kiln to incinerate contaminated soils has been limited. At present, the EPA and one private firm have developed transportable RKI units, and at least three firms operate stationary RKI units for hazardous waste incineration. These units are described in the following paragraphs.

EPA Mobile Incinerator. Rotary kiln incineration of TCDD-contaminated soil and liquid was done at the Denny Farm site in southwest Missouri in a trial burn program conducted between February and April of 1985. The EPA mobile incinerator was used for the trial burn program, which consisted of four separate burns. During the trials, 1,750 gal of TCDD-contaminated liquid and 92,000 lb of TCDD-contaminated soil were incinerated. The liquid and soil had average TCDD concentrations of 230 and 500 ppb, respectively. All trial burns achieved a TCDD destruction removal efficiency (DRE) exceeding 99.9999 percent. Table 5-8 presents the results of the trial burns.

A solids feed rate of 1,500 lb (approximately 3/4 yd^3 of soil) per hour was maintained through the incinerator during the trial burns. The rotary kiln operated at about 1,800°F and the afterburner at about 2,200°F. The residence time for soil in the incinerator was about 30 min. TCDD in the

Table 5-8
RESULTS OF TCDD TRIAL BURNS WITH EPA MOBILE INCINERATOR
(Through April 8, 1985)

Trial Burn	TCDD Concentrations of Input	Stack Emissions (mg) TCDD (per day)	Stack Emissions (mg) Particulates (per cubic meter)	Percentage of TCDD Destruction[a]
1	Liquids--249 ppm Soil--101 ppb	ND	134.3	>99.999973
2	Liquids--357 ppm Soil--382 ppb	ND	147.3	>99.999986
3	Liquids--264 ppm Soil--1,010 ppb	ND	145.6	>99.999995
4	Liquids--225 ppm Soil--770 ppb	ND	201.5	>99.999989

[a]Destruction removal efficiency.

NOTES: Total amounts incinerated; 1,750 gal of liquids; 92,000 lb of soil.

No TCDD found in other incinerator wastes (kiln ash: nondetectable TCDD less than part per trillion [ppt]; purge [rinse] water: nondetectable TCDD [less than 3 parts per trillion].

mg = miligram; ND = not detected; > = greater than; gal = gallons.

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ash (treated soil) from the incinerator was below detection limits during all trials.

During the trial burns, problems were encountered with particulates building up in the afterburner and carrying through the scrubber and out the stack of the incinerator. Although the stack particulate emission standards were not exceeded during the trial burn, particulate emission control may be a problem during future incineration activities. Particulate loading in the afterburner was also a limiting factor in the soil throughput rate; inputs greater than 1,500 lb per hour probably would be possible with the EPA unit if the particulate carryover problem were solved. The EPA has modified the ductwork between the kiln and the afterburner, and it is expected that this modification will solve the particulate carryover problem. 009743

The EPA conducted a field demonstration test of the mobile incinerator during the second half of 1985. This test was designed to demonstrate whether the process has any long-term operational limitations and to provide information on the cost of the process. By January 2, 1986, over 800 tons of TCDD-contaminated soil and over 120,000 lb of TCDD-contaminated liquid from southwest Missouri were destroyed. The ash from the field demonstration was delisted and returned to the cleanup area.

Private Operators. Private firms in the United States known to have experience incinerating TCDD-contaminated wastes or PCB's in RKI units are:

- Rollins, Inc., of Deer Park, Texas, which has successfully burned TCDD-contaminated wastes in its stationary facility; however, Rollins has incinerated only small amounts of contaminated soil. Rollins has expressed interest in accepting more TCDD-contaminated waste for incineration at Deer Park.

- ENSCO, Inc., of El Dorado, Arkansas, which has extensive experience with PCB incineration in its stationary RKI facility. However, it has not accepted TCDD-contaminated wastes and has expressed no interest in doing so in the future.

- PYROTECH, an ENSCO subsidiary based in Nashville, Tennessee, has two transportable RKI units similar to the EPA mobile incinerator. One of these is successfully incinerating waste-oil-contaminated soil at the Sydney Mine site near Tampa, Florida. That soil does not contain TCDD.

  The second incinerator has yet to undergo EPA certification testing for TCDD incineration. It is expected to be available for use shortly after testing. PYROTECH has scheduled its transportable units for TCDD incineration work at the Vertac site (still bottoms) and the Peeck Oil site near Tampa, Florida, in the near future and has expressed strong interest in doing additional TCDD incineration in the future. PYROTECH has indicated that they may construct two or three more transportable incineration units over the next 2 yr.

The rest of the discussion on incineration will focus on the ways to apply RKI technology to the Vertac Offsites, according to the two thermal treatment alternatives: 009744

- o Local incineration
- o Nonlocal incineration (existing facility)

LOCAL INCINERATION

This alternative will consider the use of a mobile incinerator for destruction of the TCDD-contaminated materials. For the reasons stated previously, the mobile units that will be used as a basis for evaluation and cost estimation for the remainder of this study will be rotary kiln incinerators. If local incineration is selected as the remedial action for the site, then the actual process selection will be determined during final design.

Facility Description

ENSCO is planning to construct an incinerator at the Vertac plant site to treat contaminated wastes. This incinerator may be available for incinerating offsite wastes. The costs for local incineration would be less if the incinerator at the Vertac plantsite could be used instead of building a new incinerator at the wastewater treatment plant. However, since the availability of this incinerator is uncertain, it was assumed that a temporary incineration facility would be constructed near the wastewater treatment plant. A conceptual layout of the incineration facility is shown in Figure 5-7.

It is assumed that a transportable incinerator similar to the EPA or PYROTECH mobile rotary kiln incinerators would be used at the site. The throughput rate is determined by the incinerator design.

The EPA and PYROTECH mobile rotary kiln incinerators consist of trailer-mounted sections of the basic incinerator facility. The EPA mobile incinerator, for example, consists of three main 45-ft-long trailers. One trailer holds the rotary kiln and ram feed system, the second trailer has the secondary combustion chamber, and the third trailer contains the scrubber. Interconnecting ducts, stack monitoring devices, and

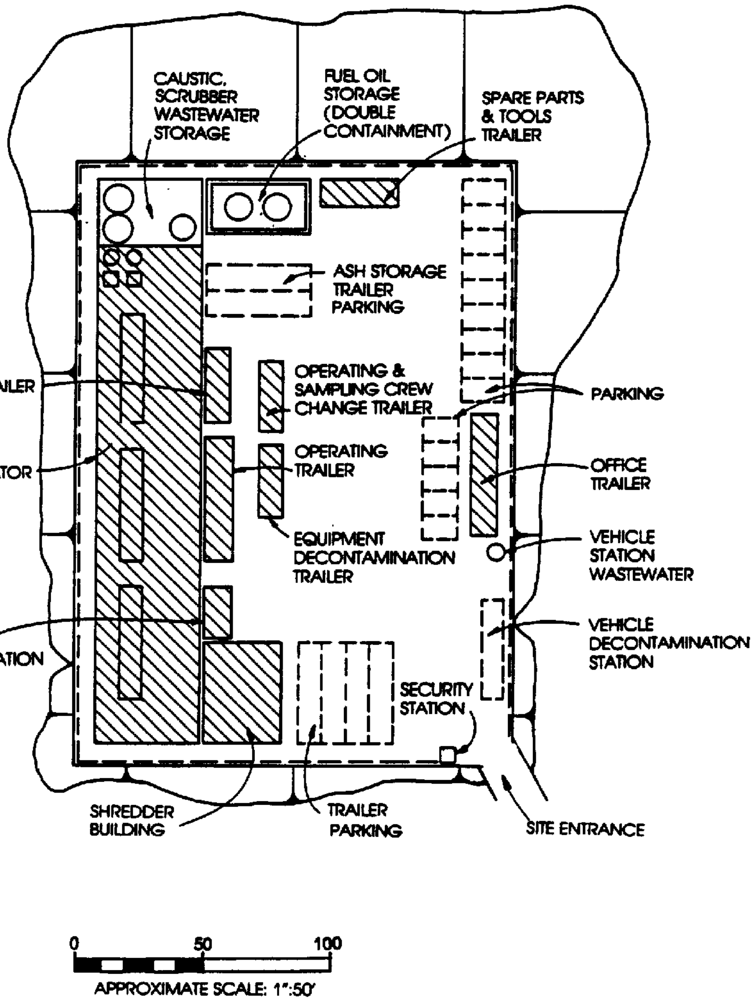

Figure 5-7
Local Incineration Facility
Conceptual Layout

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other equipment are shipped to the site on additional trailers. A drawing of the EPA mobile incinerator is shown in Figure 8.

The PYROTECH transportable incinerator is similar to the EPA unit, but with several differences.

- It is larger than the EPA unit. The PYROTECH unit's kiln volume is nearly six times greater than that of the EPA unit, and its heating capacity is nearly four times greater. This permits faster soil throughput.

- The PYROTECH unit includes a fourth trailer that houses a heat-recovery steam boiler; this serves as prime mover for the unit and replaces the induced draft fan of the EPA unit. Replacement of the induced draft fan also allows the PYROTECH unit to operate more quietly than does the EPA unit.

The transportable incineration equipment and support trailers would be transported to the site and assembled following site preparation. Equipment to be assembled at the site includes:

- Transportable incinerator units--This would include the trailers containing the major elements of the incinerator, a trailer containing stack monitoring equipment and associated ducting and other equipment required for operation of the incinerator. Backup power generators would also be required at the site in the case of a power outage.

- Raw soil-handling and size-reduction equipment--It is expected that soil would be brought into a shredder building in polypropylene bags, fed into the size-reduction equipment to break up large clumps of soil, and then conveyed to the feed ram of the incinerator.

- Fuel oil, discharge scrubber water, and caustic storage tanks--The fuel oil and discharge scrubber water tanks would be about 20,000 gal each.

- Support trailers--This would include a trailer containing personnel decontamination and sanitary facilities, an office trailer, and a trailer containing spare parts and repair equipment for the entire incineration facility. These support trailers would be positioned on railroad ties or other temporary supports as required at the site.

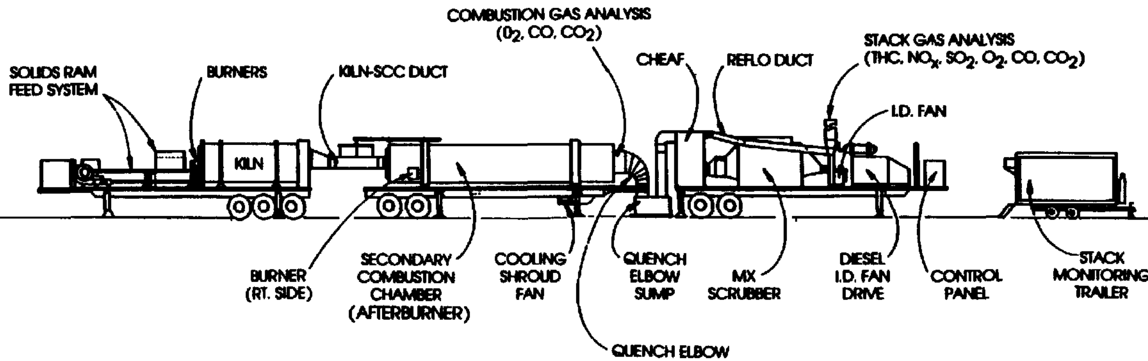

Figure 5-8
Process Equipment Diagram
EPA Mobile Incinerator

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Buildings to house the incinerator and shredder equipment would be constructed at the site prior to placement of incinerator equipment.

Mobilization and Site Preparation

The following site preparation would be required to allow operation of a transportable rotary kiln incinerator at the site:

- o Upgrading of the utilities at the site including upgrading of the local residential power to the 440-volt, three-phase power required for operation of an incineration unit.

- o Preparation of the area for construction of the incinerator facility. This would include clearing the area of brush and debris, regrading and compacting the area to produce a level area about 350 ft by 100 ft, and placing a gravel base over the entire area.

- o Construction of building floor slabs and diked tank areas. Two buildings are anticipated for the site, one for the incineration facility and a second, smaller building containing soil preparation equipment. The shredder building would operate at negative pressure with discharge air microfiltration to prevent TCDD-contaminated dust from leaving the building. In addition to the building slabs, diked tank areas would be required for the scrubber water, caustic storage tanks, and the fuel oil storage tanks.

- o Construction of auxiliary facilities. This would include construction of perimeter fencing around the site and overhead pole lighting, a security station, and a well to produce at least 50 gpm of water to be used for scrubbing exhaust air from the secondary combustion chamber.

Following preparation of the site, the transportable incineration equipment and support trailers would be transported to the site and assembled.

Facility Testing and Operation

After onsite assembly, the incineration and materials handling equipment would undergo shakedown testing and adjustment lasting perhaps 30 days. During this time, individual equipment items and systems would be checked for proper function following relocation and reassembly. This would allow problems to be corrected before TCDD incineration began, reducing the possibility of delays or equipment breakdown while handling hazardous materials later in the project. Testing would conclude with sample incineration runs, first on noncontaminated soil, and finally on the contaminated materials under actual operating conditions.

Following successful shakedown testing, the incinerator would begin incinerating TCDD-contaminated soil. The sequence of operations would be as follows:

1. TCDD-contaminated materials would arrive from the temporary storage structures, dewatering facilities (by sealed conveyor), or directly from the excavation site, and then be loaded into a hopper.

2. The material would drop into a shredder, which would break up large clumps and bulky debris. The material would be carried by a sealed conveyor to the ram feeder of the incinerator, where it would be fed into the incinerator kiln.

3. Following incineration, the ash would probably be cooled with water and mechanically conveyed to a temporary storage facility. It would then be tested for residual TCDD contamination.

4. Successfully treated material would then be delisted and hauled to an approved solid waste landfill for final disposal.

Demobilization and Site Restoration

Demobilization of the incineration facility and restoration of the site would be performed following the completion of incineration activities. Demobilization and site restoration would include the following activities.

- Decontamination of the shredder, conveying equipment, and shredder building. This work would be performed in Level C personal protective gear and would include washdown and steam cleaning of the equipment and collection of the washdown water. The collected washdown water would be injected in the incinerator for disposal.

- Shutdown and dismantling of the incinerator and auxiliary equipment.

- Dismantling and removal of the incinerator building. This building should be salvaged for use at other sites.

- Removal of the incinerator and auxiliary equipment and transport to the next site slated for use.

- Removal of perimeter fencing and the security station.

- Regrading and revegetation of the site.

NONLOCAL INCINERATION (EXISTING FACILITY)

The incineration facilities that will be considered for this alternative will be those hazardous waste incinerators that already have solids handling capability and are currently permitted to incinerate PCB's. The preamble to the January 14, 1985 dioxin regulations states a preference for solids-capable PCB incinerators as incinerators for TCDD incineration. Because of this stated preference and because no commercial incinerators exist in the country that have the necessary permits for incineration of TCDD-contaminated soil, the description and evaluation sections of this study will assume that the units for offsite incineration of the contaminated soil will be one of the solids-capable PCB incinerators.

For this alternative, contaminated material would be removed from the site and transported to an offsite commercial hazardous waste incinerator. There are presently several commercial solid hazardous waste incinerators in the United States; few are interested in, and none have permits for, TCDD destruction. However, several are expected to have permits in the future. One commercial facility exists in Arkansas.

Facility Locations and Descriptions

The following companies maintain stationary hazardous waste incinerators, all of the rotary kiln type:

- Rollins, Inc.: Rollins maintains three hazardous waste incinerators located in New Jersey, Louisiana, and Texas. The Deer Park, Texas, facility has not been able to incinerate TCDD-contaminated materials since July 15, 1985, because of new EPA regulations. Rollins applied to EPA Region VI for approval to incinerate TCDD under the new regulations in April 1985, but their application has not yet been approved. Rollins has not accepted TCDD-contaminated wastes since July 1, 1985.

- Chemical Waste Management Inc.: This firm operates an incinerator in the Chicago area. However, the firm said it has no desire to accept or dispose of TCDD-contaminated wastes.

- ENSCO: ENSCO, the parent company of PYROTECH, has a stationary PCB-licensed incinerator facility in

El Dorado, Arkansas. However, in recognition of local public opposition, the firm has promised the city it will not handle TCDD-contaminated wastes.

TCDD-contaminated soil from the site would be transported to a nonlocal incinerator using 12- to 16-yd^3, covered trucks. The heavy truck traffic into and out of the site may require upgrade of the roads between the site and closest major road to the site. Upgrade of the roads may include widening, as well as regrading and paving.

Transport of TCDD-contaminated material would require a Uniform Hazardous Waste Manifest in compliance with 40 CFR 262.

ULTIMATE WASTE MANAGEMENT--DISPOSAL

LOCAL DISPOSAL

This alternative includes permanently containing the contaminated materials from the waterways and the flood plain in disposal facilities constructed in the vicinity of the wastewater treatment facilities. The design criteria and assumptions for this disposal alternative are given in Table 5-9. The layout of disposal facilities and associated waste handling facilities is shown in Figure 5-9. These facilities would be constructed on a engineered fill to keep the structures 10 ft above the historically high groundwater level. The facilities would be designed to meet all pertinent regulations for hazardous waste disposal.

Following preparation of the facility bases and sidewalls, TCDD-contaminated sediments from the waterways and flood plain would be moved from the local temporary storage structure(s), removed from solids dewatering facilities, or hauled directly from excavation and then placed in the disposal facilities. After all of the materials are placed in each disposal facility, a cover would be constructed on the disposal facility. Debris from the waterways and floodplains would be placed in a separate disposal facility with a fixed roof. After the last disposal facility is filled and covered, the temporary storage structures would be removed, and the site restored as much as possible.

Disposal Facility Construction Requirements

Wastes containing TCDD are federally regulated under RCRA of 1976 (reauthorized November 1984). Specific regulations are found in Title 40 of the Code of Federal Regulations (40 CFR), Subchapter I (Solid Wastes)*. New regulations governing acute hazardous wastes (including TCDD wastes) were published January 14, 1985, in the Federal Register and became effective on July 15, 1985. Additional proposed regulations for land disposal restrictions for TCDD-contaminated wastes were published in the January 14, 1986, Federal Register.

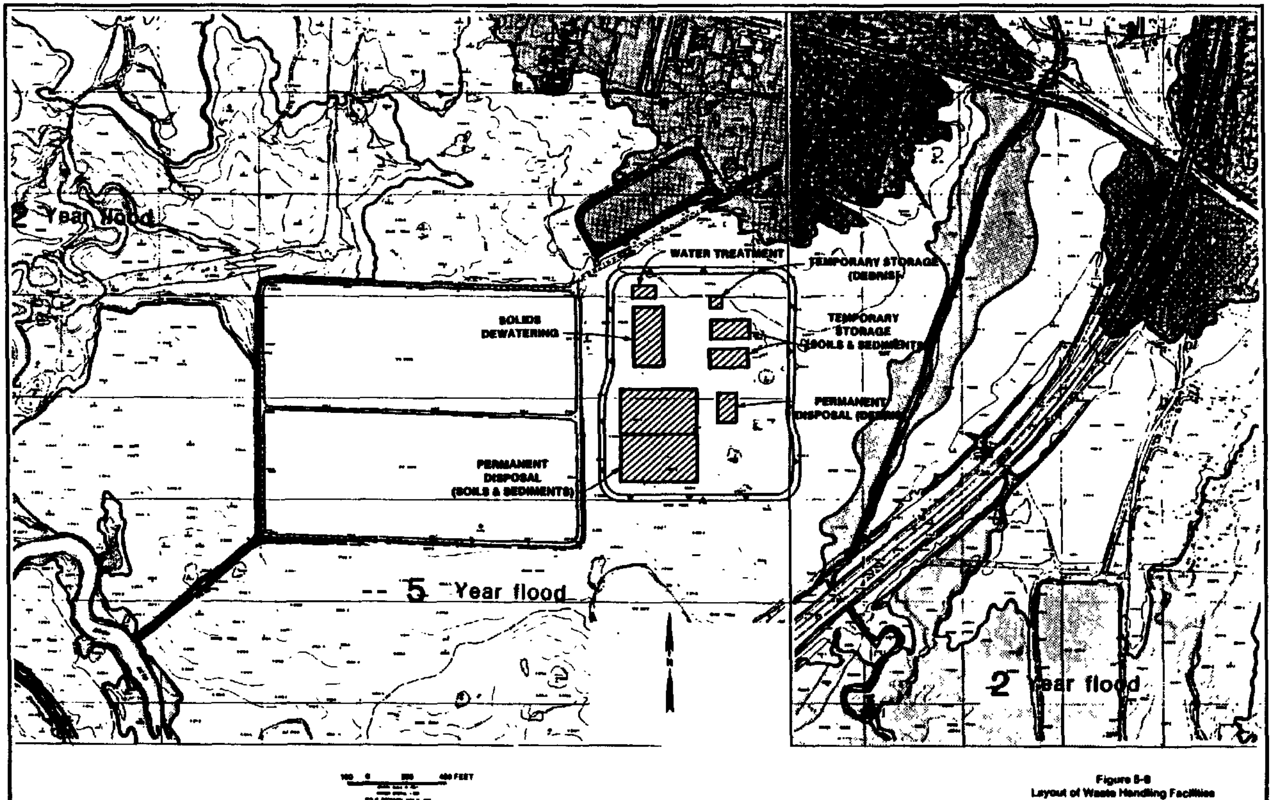

Figure 5-8
Layout of Waste Handling Facilities
Waterways and Floodplain
Local Disposal

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Table 5-9
DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS
LOCAL DISPOSAL FOR WATERWAYS AND THE FLOOD PLAIN

Sediment/Soil Disposal Facilities	
Number	2
Disposal Capacity of each facility, yd^3	35,000
Area required, ac	4.5
Construction details	See Figure 5-10
Leachate treatment plant	
Proposed processes	See Figure 5-3
Capacity, mgd	2
Debris Disposal Facility	
Number	1
Disposal Capacity, yd^3	3,000
Area required, ac	0.5

While onsite actions taken under CERCLA do not require RCRA permits, they must meet the intent of RCRA. Since the EPA has interpreted "onsite" to encompass contaminated areas, "offsite" of the primary property of consideration for an NPL site ("onsite" and "offsite" areas must both be part of the NPL site), the local disposal alternative for this Vertac offsite FS would not require RCRA permits.

Several provisions of the RCRA reauthorization of November 8, 1984, affect land disposal of hazardous wastes. The first requires all new or expanded hazardous waste facilities to have double containment of wastes with a leachate collection system above the top liner and leak detection system between the primary and secondary liners; the facilities must also have groundwater monitoring systems. Another provision of the reauthorization bans land disposal of dioxins after November 8, 1986, unless the EPA first issues regulations defining safe disposal practices.

Site Preparation

Construction of local disposal facilities would require extensive site preparation prior to construction. A disposal facility would need to be constructed on a relatively flat area with engineered fill as needed to provide adequate soil stability and minimum height above the historically high water table. An earthen or concrete embankment would need to be designed and constructed to protect the facilities from flooding. Preparation of a flat area large enough to accommodate the disposal facilities would require substantial clearing of trees and vegetation.

Temporary storage structures, solids dewatering facilities, and water treatment facilities, needed for waterway or wastewater treatment facility remedial actions would probably be constructed in the vicinity of the wastewater treatment facilities. Locating these other facilities in this area restricts the area available for disposal facility construction.

Approximately 4.5 acres of level area would be required for siting of a disposal facilities for the contaminated materials from the waterways and flood plain.

Disposal Facility Construction Details

The construction details of the disposal facility are shown in Figure 5-10. The design criteria and assumptions are listed in Table 5-9. The contaminated sediments from the waterways and flood plain would be disposed in two open-topped, reinforced concrete boxes. Two facilities were assumed to expedite the availability of facilities and to allow for sequential filling and closure operations. After wastes are placed in each facility, a flexible cover is installed. The features of a typical facility are discussed in more detail below.

The approximate outside dimensions of each facility would be 200 by 370-ft. The wall height would be 15 ft, which would allow for waste 11 ft deep at the wall. The concrete floor slab would be 8 in. thick, and the walls, 18 in. thick. The slope assumed for the composite cover is 5 to 10 percent, and the total depth of the waste at the center of the pile is approximately 18 ft. Construction of the base and sidewalls of the facility and of all layers of the cover above the synthetic membrane is assumed to require Level D worker protection. Construction of the lower layers of the cover are assumed to require Level C protection.

Base and Walls. The concrete disposal facility would have a double-liner base with leachate collection and leak-detection systems. The primary liner would consist of an impermeable layer (polymeric asphalt coating or synthetic liner) over the concrete floor slab. A synthetic liner could be one of a variety of synthetic materials such as Hypalon (chlorosulfonated polyethylene), chlorinated polyethylene (CPE), polyvinyl chloride (PVC), or HDPE.

Above the impermeable layer, a leachate collection system would consist of a network of perforated plastic pipe embedded in a layer of drain gravel, bounded by layers of geotextile. The upper layer of geotextile maintains separation

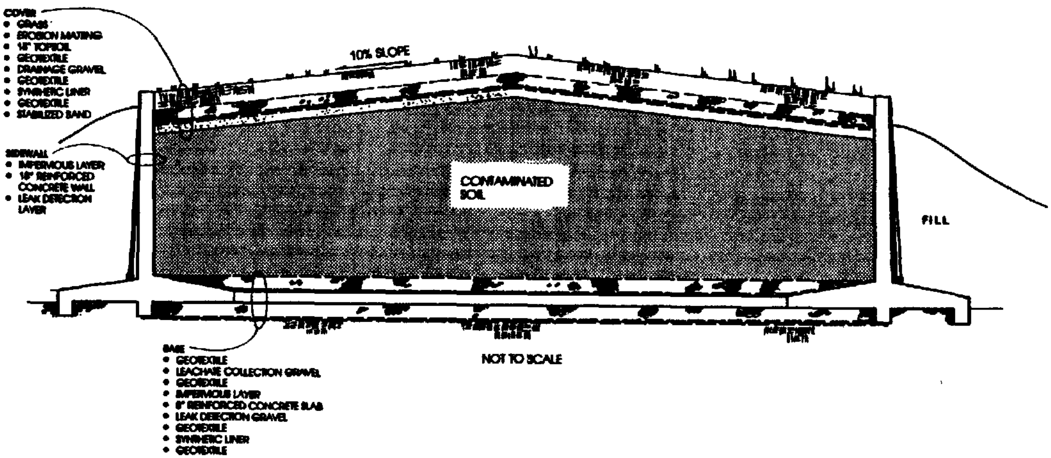

Figure 5-10
Example of Local
Concrete Disposal Facility

of the contaminated materials from the drain gravel but allows movement of leachate across the boundary under the influence of gravity. The drain pipe conducts the leachate to a sump from which it is pumped to the leachate treatment facility. The lower layer of geotextile acts as a cushion between the leachate collection gravel and the impermeable layer over the concrete base slab.

A leak detection system between the concrete slab and the subgrade would consist of a network of perforated plastic pipe embedded in drain gravel, underlain by a synthetic membrane sandwiched between cushioning layers of geotextile. This leak detection system may be divided into zones, each with a separate drain pipe running to a leak detection sump. Dividing the floor leak detection system makes it easier to locate any failures that may occur in the floor slab. Leachate collected in the leak detection system would be pumped to the contaminated water treatment system.

The walls of the facility would include a leak detection system against the outside face of the wall. A leachate collection system would not be required on the inside face of the wall, as fluids in the contaminated materials would move downward under the action of gravity to the collection system above the concrete floor slab. Because this collection system would not permit leachate to build up more than one foot of hydrostatic head on the floor slab, there would be a low potential for leaks. A cross section of the wall from inside to outside would consist of an impermeable layer, the concrete wall, and a drainage layer. At the foot of the exterior of the wall is a collection pipe that conducts any leakage to the leak detection sump.

Cover. When filled, the concrete disposal facility would be covered with a flexible, composite cap. The function of the cap would be to prevent percolation of rainwater into the contaminated materials, to minimize maintenance, and to provide security against public exposure to the contaminated materials.

The cover would consist of nine layers. From the contaminated material up, these layers would consist of a layer of stabilized sand, a synthetic liner sandwiched between protective layers of geotextile, a drainage layer, geotextile, and compacted topsoil with erosion matting and a grass cover. The cover would be dome-shaped with slopes between 5 and 10 percent. These layers are described in more detail below.

The stabilized sand layer would overlie the contaminated material. It would function as a collection layer for gases generated within the waste and would provide a suitable surface on which to place subsequent layers of the cap. The sand layer would be a minimum of 6 in. thick, and compacted to a high relative density.

The synthetic membrane overlying the stabilized sand would be constructed either of Hypalon or CPE with a minimum thickness of 30 mils. The synthetic membrane would be penetrated by vent stacks, which relieve gas that may be generated within the contaminated materials by organic decomposition. The vent stacks would be bonded to the membrane and the tops would be constructed with fittings to prevent influx of rainwater. The synthetic membrane would be sandwiched between protective layers of nonwoven geotextile, which would be a minimum of 110 mils thick.

Atop the impervious membrane would be a 12-in.-thick layer of clean granular drain material. The gradation of this material would be similar to standard 1-1/2-in.-minus concrete aggregate. The drainage layer would be covered with a separation layer of geotextile followed by 12 in. of topsoil. The topsoil is compacted and covered with erosion matting and seeded. Erosion matting will help to stabilize the topsoil until the grass cover establishes a root system.

After installation of the cover, uncontaminated surface runoff would be collected in surface trenches and routed to the natural drainage system for the area by gravity.

Contaminated Materials Placement and Facility Closure

The onsite concrete disposal facility alternative would involve transportation and placement of TCDD-contaminated materials from temporary storage or directly from solids dewatering facilities. The containerized waste from temporary storage would be placed on flatbed trucks for transport to the facility where it would be dumped. It is estimated that a working crew could maintain an average transport/placement rate of 16 yd^3/hr. The waste would be spread and compacted within the tank by a bulldozer towing a sheepsfoot compaction roller. All equipment operators are assumed to require Level C protection, and all equipment would require decontamination at the end of the job or when the equipment is removed from the site.

A leachate treatment plant to treat runoff and leachate from the facility during filling would be designed to handle the expected flow from a 24-hr, 25-yr storm. To prevent accumulation of leachate above the primary liner during this storm, it is estimated that the plant must have a treatment capacity of 400 gpm (the facility would be sized larger with two 1-mgd redundant systems as needed for handling the flow from the waterway excavation operations). Because the disposal facility would be open during placement of the wastes, the runoff from the tank would have high levels of suspended solids. The treatment equipment would include a packaged water treatment plant (includes coagulation, settling basin, multimedia filters), cartridge filters, and carbon adsorption beds together with the associated pumps, tanks, piping, and a steel building enclosure.

Facility Postclosure Requirements

Operation and maintenance (O&M) requirements would include periodic inspection of the containment walls for leaks, cracks, and distortion. The cover will require inspection for erosion, depressions, animal burrows, deep-rooted plants, and other signs of actual or potential damage.

The following O&M activities would be required regularly:

- o Maintenance of security system (fences, lights, signs)
- o Maintenance of leachate collection and leak detection sumps, pumps, and piping
- o Maintenance of site run-on/runoff control, culverts, and ditches
- o Operation/maintenance of leachate treatment plant
- o Leachate sampling and testing (until volume of leachate diminishes)
- o Groundwater sampling and testing

Debris Disposal Facility Construction Requirements

Contaminated debris from the waterways and flood plains would be disposed in a reinforced concrete box with similar base and wall construction, as described for the sediment storage facilities, but with steel structural members, metal sandwich siding, and a fixed cover.

The fixed roof facility would have multilayered base as described for the reinforced concrete boxes. The walls would rest on curbed extensions of the coated concrete floor system. The wall construction would be steel structural members with metal sandwich siding. The interior walls would be plywood-lined to prevent damaging of the siding during facility filling operations. An example roof system would be aluminum V-beam roofing supported by steel trusses. A heating, ventilation, and air conditioning (HVAC) system and baghouse discharge would be included in the fixed roof facility to allow maintenance of a slightly negative pressure in the facility. Bagged mulched debris would be transferred from temporary debris storage and placed in the fixed roof facility.

NONLOCAL DISPOSAL IN RCRA FACILITY

For this alternative, excavated soil/sediments from the waterways would be hauled from temporary storage and/or from the excavation site or dewatering facility to an offsite commercial hazardous waste landfill. (The sediments from the waterways would be dewatered before hauling to disposal site). The layout for the waste handling facilities is the same as for the incineration alternatives shown in Figure 5-5.

RCRA regulations on TCDD became effective on July 15, 1985. RCRA requires that TCDD waste be placed only in facilities fully compliant with 40 CFR 264. This requires that offsite commercial landfills have RCRA Part B permits to accept the TCDD-contaminated materials from the contaminated wastewater treatment facilities. As of this writing, no commercial facilities have RCRA Part B permits, but several may receive such permits in the near future. Available information on the locations of commercial waste management facilities shows several facilities within a 500-mile radius of the site, which could potentially be willing and able to accept these contaminated materials.

TCDD-contaminated soil would be transported to an offsite landfill using 12- to 16-yd^3, covered trucks. The heavy truck traffic into and out of the site may require the upgrade of roads between the site and major highways. Upgrading the roads may include widening as well as regrading and paving.

Transport of TCDD-contaminated material would require a Uniform Hazardous Waste Manifest in compliance with 40 CFR 262.

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Section 6
DEVELOPMENT OF REMEDIAL ALTERNATIVES FOR WASTEWATER FACILITIES

The remedial technologies retained for the wastewater facilities, shown in Figure 6-1, are assembled into remedial alternatives and developed in this section. The remedial technologies are classified under two primary categories: management of migration and ultimate waste management. The proposed waste handling technologies are also discussed. Figure 6-2 indicates the primary waste management steps, or technologies, involved with each of the seven alternatives developed for the wastewater facilities:

- No action
- Restrict access, abandon facilities, and monitor migration
- Local incineration
- Nonlocal incineration
- Local disposal
- Nonlocal disposal in RCRA facility
- Disposal in wastewater facilities

A remedial alternative may contain only one technology.

The wastewater facilities are described below:

- The aeration basin and oxidation ponds that comprise Jacksonville's WWTP (see Figure 2-6)
- The 1,760-ft outfall ditch from the oxidation ponds to Bayou Meto
- The abandoned wastewater treatment facilities (Old Treatment Plant), which includes two primary clarifiers, one sludge digester, two trickling filters, two secondary clarifiers, approximately 0.5 ac of sludge drying beds, approximately a 700-ft outfall ditch to Rocky Branch, and a pumping station (see Figure 2-5)
- Approximately 14,700 ft of sewers of which 4,350 ft are the abandoned Rocky Branch interceptor (See Figure 2-4)

These facilities are described further in the RI report.

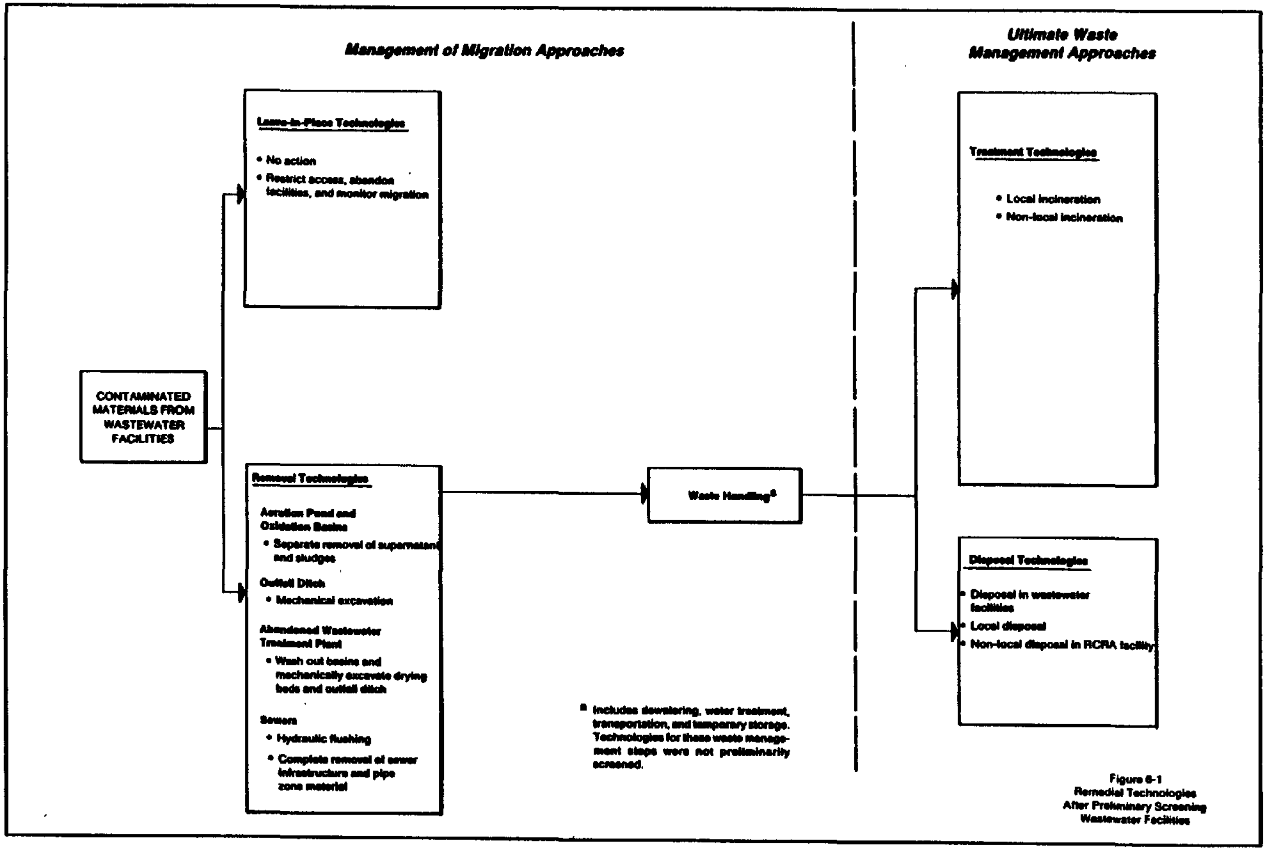
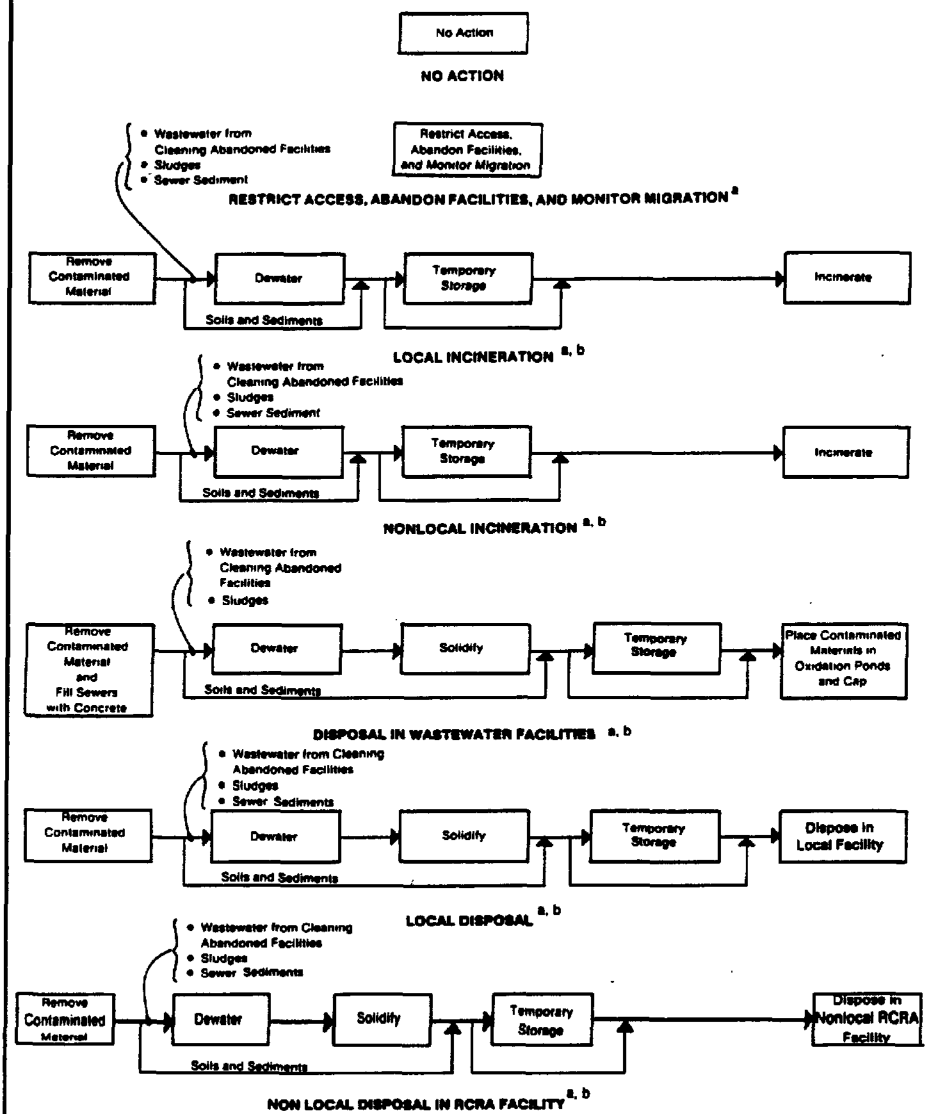


Figure 6-1
Remedial Technologies
After Preliminary Screening
Wastewater Facilities



[a] These alternatives include a mobile water treatment facility.
[b] These alternatives include a main water treatment facility.

Figure 6-2
Waste Management Steps for Remedial Alternatives
Wastewater Facilities

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MANAGEMENT OF MIGRATION--LEAVE-IN-PLACE

Two leave-in-place alternatives were retained for further consideration: (1) no action, and (2) restrict access, abandon facilities, and monitor migration.

NO ACTION

The no action alternative consists of taking no action to control the migration of TCDD-contaminated material, to reduce exposure to TCDD, or to monitor the extent of contamination.

RESTRICT ACCESS, ABANDON FACILITIES, AND MONITOR MIGRATION

The assumptions and design criteria for this alternative are presented in Table 6-1.

Access to the aeration basin, oxidation ponds, and abandoned wastewater treatment plant would be restricted by installing a 6-ft-high, chain-link fence topped with strands of barbed wire around the facilities. Access to the sewers would be restricted by installing locking manhole covers. Access would be further restricted by increasing public awareness of the hazards associated with the contaminated areas and by posting signs.

Abandonment of the facilities would consist of no longer using the aeration basin, oxidation ponds, outfall ditch, and sewers to treat and convey wastewater. Jacksonville is planning on constructing a new wastewater treatment plant within a few years that will treat the municipal wastewater currently treated at the contaminated aeration pond and oxidation basins. Therefore, construction of new wastewater treatment facilities is not included under this alternative. New sanitary sewers, however, would have to be installed to replace the currently active sewers that are abandoned. The design of these sewers was assumed to be similar to the design of the abandoned sewers. Abandonment of the sewers would consist of plugging the upstream and downstream ends of the contaminated sewer and each service and lateral connection with concrete.

Future monitoring would partly consist of testing for TCDD in samples taken from the new sewers, from soils adjacent to the abandoned treatment and conveyance facilities, and from the bayou near the discharge point of the outfall ditch. The results will help indicate the extent of continued TCDD migration. It was assumed that samples would be biannually collected and tested from 10 sites, indefinitely. In addition, a groundwater monitoring program would be established. The extent of the groundwater monitoring program cannot be determined without additional hydrogeological information.

Table 6-1

DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS--

RESTRICT ACCESS, ABANDON FACILITIES, AND MONITOR MIGRATION ALTERNATIVE FOR WASTEWATER FACILITIES

<u>Extent of Remediation</u>	
Areas to be Remediated:	o Aeration basin o Oxidation ponds o Oxidation pond outfall ditch o Abandoned wastewater treatment plant o 14,700 feet of sewer
<u>Site Preparation</u>	
Clearing, ac	1
Existing roads to be upgraded, ft	10,000
<u>Remediation Action</u>	
Fence, ft	13,000
Sewer concrete plugs, number	27
<u>Installation of New Sewer</u>	
Length of new sewer, feet	
8"	590
10"	2,520
12"	2,998
15"	1,266
18"	1,699
20"	202
21"	789
24"	318
TOTAL LENGTH	10,400
Manholes, number	54
Service and lateral connections, number	21
<u>Groundwater Monitoring</u>	Extent of groundwater monitoring cannot be determined without additional hydrogeologic information
<u>Sediment/Soil Monitoring</u>	
Number of monitoring sites	10
Frequency of sampling	Biannually
Duration of sampling	Indefinite
<u>Restoration</u>	Minimal

NOTES: Ground is sufficiently stable to support construction activities.

Existing fence around the abandoned wastewater treatment plant is insufficient to restrict access.

A new wastewater treatment plant will be built that will treat the municipal wastewater currently treated at the contaminated aeration pond and oxidation basins.

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MANAGEMENT OF MIGRATION--REMOVE MATERIAL

This subsection develops technologies for removing the contaminated materials in the wastewater facilities. Table 6-2 presents the design criteria and major assumptions in developing the removal technologies.

OXIDATION PONDS AND AERATION LAGOON

The removal technologies proposed for liquids in the aeration lagoon and oxidation ponds were selected such that the sludges and supernatant could be removed separately. This is advantageous since it reduces the load on the dewatering system. (The solids in the supernatant would be removed at the water treatment plant).

The access road to the impoundments would probably require upgrading to handle the increase in construction equipment traffic.

A submersible, centrifugal pump mounted on a steel, rigidly reinforced, foam-filled pontoon would be used to first remove the sludge on the bottom of the basins. It was assumed that the pump/pontoon would be purchased and would be salvageable for future projects. The minimum amount of water the pontoon can work in is about 2 to 2.5 ft. This minimum depth can be maintained in the aeration lagoons while completely removing all of the estimated sludge. However, based on the supernatant estimates, this minimum depth cannot be maintained in the oxidation ponds and still completely remove the sludge. Therefore, supernatant from one oxidation pond would be pumped into the other pond to provide sufficient depth for the pump/pontoon. After the sludge is removed in this pond, supernatant would be pumped into the other pond so that the sludge could be removed in that pond.

After the sludges are removed, most of the supernatant would be pumped out via the existing outlets on the west end. The remaining water would be removed by constructing drainage ditches and installing sump pumps. The supernatant would be treated at the proposed water treatment plant.

After the sludges and supernatant are removed, the basin walls and bottom would be tested for TCDD. It was assumed that five samples from the aeration basin and 20 samples from the oxidation ponds would be collected and tested. If the TCDD levels are unacceptable, additional material would be excavated from the basin walls and bottoms and the TCDD levels would be redetermined. It was assumed that the TCDD levels would be acceptable and additional excavation would not be required.

Table 6-2
DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS--
REMOVE MATERIAL ALTERNATIVE FOR WASTEWATER FACILITIES

Oxidation Ponds and Aeration Lagoon		
Supernatant wastewater		
Volume of material, MG		
Aeration Basin		6.8
Oxidation Ponds		30
Percent solids[a], %		1
Method of removal		pumping
Rate of removal, gpm		1,000
Subnatant sludge		
Volume of material, MG		
Aeration Basin		1.6
Oxidation Ponds		42
Percent solids[a], %		5
Method of removal		pumping
Rate of removal, gpm		500
Postcleaning TCDD testing, number of samples		25
Outfall Ditch		
Pre-excavation TCDD testing, number of samples		10
Length, feet		1,760
Width of contaminated material, ft		4
Depth of contaminated material, in.		12
Volume of contaminated material, yd^3		260
Volume of overexcavated material, yd^3 [b]		40
Wet density, lb/ft^3		125
Moisture content, %		15
Method of removal		backhoe
Postexcavation TCDD testing, number of samples		10
Abandoned Wastewater Treatment Facilities		
Two Primary Clarifiers		
Type of contaminated material	Water standing in basins	
Volume of contaminated material, gal		126,000
Method of removal	Vacuum pumping	
Sludge Digester		
Type of contaminated material	Digested sludges at assumed 5% biological solids	
Volume of contaminated material, gal		179,000
Method of removal	Vacuum pumping	
Two Trickling Filters		
Type of contaminated material	Contaminated sediments on approx. 600 yd^3 of 3- to 5-in. stones	
Volume of sediments removed, yd^3		50
Volume of washwater, gal		82,000
Method of Removal	Jet-water wash	
Two Secondary Clarifiers		
Type of contaminated material	Sediment on the bottom of the basins	
Volume of contaminated material, yd^3		90
Method of removal	Vacuum pumping	

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Table 6-2
(continued)

Sludge Drying Beds

Type of contaminated material	Soil @ 125 lb/ft^3 wet density; 15% moisture content
Surface area, ac	0.5
Depth of removal, inches	12
Volume of contaminated material, yd^3	810
Volume of overexcavated material, yd^3 [b]	120
Method of removal	Backhoe
Postexcavation TCDD testing, number of samples	6

Outfall Ditch to Rocky Branch

Pre-excavation TCDD-testing, number of samples	6
Length, ft	700
Width of contaminated material, ft	4
Depth of contaminated material, in.	12
Volume of contaminated material, yd^3	104
Volume of overexcavated material, yd^3 [b]	16
Wet density, lb/ft^3	125
Moisture content, %	15
Method of removal	Backhoe
Post-excavation TCDD-testing, number of samples	6

Pumping Station--Wet Well

Volume of contaminated material	Assumed empty except for contaminated sediments on basin walls

Sewer System

Methods of Removal

Alternative A	Hydraulic cleaning
Alternative B	Excavation and removal of sewer pipeline, manholes, and pipe zone material

Length of Sewer[c], in.

8 in.	590
10 in.	2,520
12 in.	2,998
15 in.	3,495
16 in.	461
18 in.	3,359
20 in.	202
21 in.	789
24 in.	318
TOTAL	14,700

Manholes, number	54
Service connections, number	7
Volume of sediment removed, yd^3	43
Volume of vegetation removed, yd^3	3
Volume of water removed,[d] 1,000 gal	103
Pipe zone material,[e] yd^3	5,130

Table 6-2
(continued)

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[a]The percent solids given is assumed based on typical solids contents in similar wastewater facilities. The size and cost of subsequent remedial activities is highly dependent on the solids content of these wastewaters.
[b]Assumes 15-percent overexcavation.
[c]Sewer lengths given are the lengths of sewer that will be cleaned (Alternative A) or excavated and removed (Alternative B). The abandoned Rocky Branch interceptor which accounts for 4,350 ft of the sewer lengths (15- to 18-in. sewers) would be removed and cleaned under Alternative A and not replaced under either alternative.
[d]Applicable only to Alternative A method of removal; assumes 7 gal per linear foot.
[e]Applicable to only Alternative B method of removal.

Notes: Ground is sufficiently stable for construction equipment

Rainfall occurring during remediation activities will not significantly affect volumes of contaminated materials

The outfall ditches from the oxidation ponds and abandoned wastewater treatment plant are contaminated with TCDD

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The equipment would be decontaminated via a jet-water wash when removal is complete.

OXIDATION POND OUTFALL DITCH

Although the RI did not find TCDD levels greater than 1 ppb in the outfall ditch, the outfall ditch was assumed to require remediation since the oxidation ponds and the Bayou Meto downstream from the confluence with the outfall ditch had TCDD levels greater than 1 ppb. Prior to implementing this technology, it was assumed that 10 samples would be tested for TCDD to determine the areal extent and depth of contamination in the ditch. It was assumed that 12 in. of sediment/soil in the bottom of the ditch (4 ft wide) would require removal.

The sediment in the ditch could be removed with a backhoe while there is no flow in the ditch. Ten samples would be collected and tested for TCDD to determine the adequacy of the cleanup. No additional excavation was assumed to be required. Placement of imported soil would restore the ditch to its original configuration.

ABANDONED WASTEWATER TREATMENT PLANT

The sediments, sludges, and water in the abandoned wastewater treatment plant basins and pump station would be removed and then the basins would be cleaned. Sludges and water would be removed with a vacuum system. The sediments would be removed with a vacuum system designed for removing solids. The rocks in the trickling filter would be cleaned, delisted, and left in the filter. A hot, pressurized, biodegradable cleaning mixture was assumed to be sufficient and necessary for cleaning the basins. After the basins are cleaned, wipe samples would be taken in each basin to determine the adequacy of the cleaning. If the wipe samples indicate the cleaning was inadequate, then the basins would be further cleaned possibly with a solvent and/or by sandblasting. It was assumed that no further cleaning would be required.

The TCDD levels in the outfall ditch to Rocky Branch have not been determined. This ditch contains a pipe through which treated wastewater was discharged to Rocky Branch. If the pipeline was not watertight or if overflows were discharged into the ditch outside of the pipeline, TCDD-contamination of the ditch is likely. It was assumed that six samples would be taken from this ditch to help determine the areal extent and depth of TCDD-contamination prior to removing any material. It was assumed that 12 in. of soil over a width of 4 ft for the entire length of the ditch would have unacceptable TCDD levels and this material would be removed. Six additional samples would be tested for TCDD after excavation to determine the adequacy of the cleanup and whether additional excavation is necessary.

The soil in the abandoned sludge drying beds and in the outfall ditch to Rocky Branch would be removed with mechanical excavators such as backhoes. It was assumed that no pretesting for TCDD levels would be conducted in the sludge drying beds but that six samples would be tested for TCDD levels after excavation. Soil would be imported to restore the area and then seeded.

The method of treating the wastewater (not digester sludges) removed from the basins and produced from the cleaning operations is described under "Water Treatment" in the Waste Handling subsection. The sludges removed from the sludge digester would be dewatered prior to treatment of the water and ultimate waste management of the solids.

SEWERS

The sewer lines assumed to require remediation were shown in Figure 2-4. Contaminated sediments were assumed to not be in upstream laterals and service lines tying into the sewers that were assumed to require remediation.

Two removal technologies are described below. Alternative A consists of removing sediment from the sewers, which also will entail removal of obstacles such as roots, gravel, grease, bricks, and concrete. Alternative B assumes that the pipe zone material is contaminated. Therefore, the sewer lines and pipe zone bedding material would be removed.

Alternative A

Removing contaminated material from the sewage collection system involves several steps that are given below:

- Perform additional TCDD testing (optional)
- TV-inspect sewer lines intended to be cleaned
- Clean sewers
- Inspect sewers
- Repair sewer lines as needed

Additional TCDD tests may be performed to better define the extent and magnitude of TCDD contamination. However, it was assumed that no additional TCDD tests would be performed prior to cleaning the sewer lines and that 14,700 ft of sewers would be cleaned.

Sewer lamping, which was performed during the remedial investigation, is insufficient to determine where obstructions exist that may hinder sewer cleaning. The sewer lines would be TV inspected prior to cleaning the sewers.

The RI reported that the primary obstructions in the sewer lines were grease, roots, dirt, and gravel. Also, bricks and concrete from manholes had fallen into sewer lines. A combination of hydraulic flushing (with an optional cutter-head) and suction appears to be a cost-efficient method to adequately clean the sewers. The hydraulic force and cutter-head should adequately clear such obstructions as roots, grease, and accumulated sludge and sediments. Some sections may also require mechanical cleaning to remove major obstructions. It was assumed that 5 percent of the total sewers cleaned would require supplemental mechanical cleaning. Sections of collapsed pipeline, either existing or created during cleaning operations, would have to be repaired prior to continuing cleaning operations. The RI reported that some of the sewer lines between manholes are crooked. The 4,350-ft abandoned Rocky Branch interceptor was assumed to be structurally inadequate for hydraulic cleaning, and therefore, the entire sewer line would be dug up and cleaned to remove contaminated material. Also, 3 percent of the remaining sewer lines, in approximately 15-ft sections, were assumed to require repair.

The main advantage of hydraulic flushing is that essentially all the sediment is transported to a manhole and removed from the sewers. Hydraulic flushing generates large quantities of water (estimated at 7 gal per foot of sewer). However, the sediments can be and were assumed to be effectively removed from the water by dewatering.

To prevent the occurrence of volatile organics and contaminated sediments entering homes via service lines during the cleaning operations, devices to prevent flow into service lines and laterals would be installed, the cleaning operation would be continuously supervised, and the residents would be informed of cleanup and safety procedures.

Inspection of the sewers after cleaning would involve (1) television inspection to determine the adequacy of the cleaning and what repairs are required, (2) smoke testing to determine points of infiltration/exfiltration and unauthorized connections, and (3) obtaining wipe tests from the manholes to help determine whether the TCDD contamination had been adequately reduced. If television inspection indicates that some obstructions were not removed, then additional cleaning, probably mechanical followed by hydraulic, would be required. It was assumed that the inspection results would indicate no additional cleaning and repair would be required.

Future monitoring/testing would include analyzing sludge/sediment accumulated in the sewer lines to determine whether TCDD continues to migrate into or exists in the sewer lines. It was assumed that three samples would be taken each year for 5 yr after the cleaning operations. It was also assumed that no corrective measures would be required; that is, the future TCDD levels in the sewer lines would be acceptable.

After sewer cleaning has been completed, the equipment used for cleaning such as (trucks, pumps) would have to be decontaminated. The decontamination procedures would most likely include a jet-water wash. Water from the decontamination procedure will be captured for analysis and/or treatment. When the decontamination procedure has been completed, wipe tests will be used to sample the equipment. The wipe cloths will then be analyzed for TCDD to assure that no contamination remains on the equipment. The equipment would be impounded until the test results indicate decontamination is complete.

Alternative B

This removal technology may be selected if the granular material around the sewer lines, the pipe zone material, is suspected or known to be contaminated with TCDD. Since this technology is much more costly than the limited removal technology, the pipe zone material would probably be tested for TCDD to determine whether it is prudent to remove it. It was assumed that 10 samples of pipe zone material would be tested for TCDD prior to determining the extent of removal. It was also assumed that the length of sewer to be removed by the Alternative B method would be the same length as cleaned in Alternative A (14,700 ft).

This sewer removal technology involves removing the existing pipeline, manholes, and pipe zone material that is suspected to be contaminated. The pipes and manholes would be jet-water washed, temporarily stored until they were delisted, and then, assuming they were delisted, disposed of in a local sanitary landfill. The water generated from these cleaning operations would be dewatered and treated as described under "Waste Management". The pipe zone material would be handled as a TCDD-contaminated waste. The subsequent handling of the pipe zone material would be similar to the handling of soils removed from the abandoned sludge drying beds.

Collection and conveyance of wastewater would have to continue during the removal of the contaminated sewer lines. Therefore, a new sewer system would be installed parallel to the contaminated sewer system prior to its removal. The design of this new sewer system, for example, pipe diameters and depths, was assumed to be similar to the existing system. The abandoned Rocky Branch interceptor would not require a new parallel system.

The decontamination methods for the equipment would be the same as those proposed for Alternative A. Future monitoring was not considered necessary for this technology.

WASTE HANDLING

DEWATERING

The sludge collected from the wastewater treatment facilities would be dewatered prior to implementation of the ultimate waste management technology. Several methods of sludge dewatering are potentially applicable to the contaminated sludges, including mechanical dewatering, sand drying beds, and wedge-wire drying beds. The sand in sand drying beds would potentially be contaminated by TCDD and require subsequent hazardous waste management. A mechanical dewatering system or a wedge-wire drying bed could probably be decontaminated and reused.

It was assumed that a wedge-wire drying bed would satisfactorily dewater the contaminated sludges. This selection is based on very little information concerning the physical properties of the contaminated sludges. Additional testing of the sludges would be required prior to selecting and designing the dewatering system. The design criteria and assumptions for this dewatering system are given in Table 6-3.

System Description

The sludge dewatering system would consist of a polyethylene wedge-wire drying bed system placed on a concrete slab. The concrete slab would be underlain with a 30-mil HDPE liner, 6 in. of sand and another 30-mil HDPE liner. The concrete slab would be sloped to drain into a sump, where the water would be pumped to the treatment facility. It is assumed the sludge would be placed on the drying bed at 5-percent solids and would dewater to 25-percent solids within 1 week. The sludge would be removed using a small front-end loader (less than 4-ton net weight). Using a 1-ft-thick layer for each application, it would take approximately 2 yr to dewater the contaminated sludges using a 2-ac drying bed.

The drying bed would be covered with a greenhouse structure to allow operation in wet weather and to minimize the amount of water that must be subsequently treated. The entire facility would be constructed on an engineered fill designed to raise the facility 1 ft above the 100-yr floodwater level.

Site Restoration

Site restoration would consist of decontaminating and salvaging the greenhouse structure and polyethylene wedge-wire drying system. A jet-water wash was assumed to be adequate for decontamination. The construction materials, including concrete, sand, and HDPE liner, was assumed to not be contaminated (the concrete would be jet-water washed) and would

Table 6-3
DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS--
DEWATERING OF WASTEWATER SLUDGES

Characteristics of Wastewater Sludges	
Volume, MG	
Aeration basin	1.6
Oxidation ponds	42
Abandoned sludge digester	0.18
TOTAL	44
Solids content before dewatering, %	5
Solids content after dewatering, %	25
Dewatering Facility	
Dewatering method	Polyethylene wedge-wire Drying bed system inside a greenhouse structure
Location	Adjacent to oxidation ponds
Area required, ac	2
Dewatering rate, gal of 5% sludge per week	846,000
Leachate	
Design rate, gpm	68
Total design volume, MG	35.5
Site Restoration	
Removal and disposal of concrete slab, sand, and HDPE layer, yd^3	5,000
Decontamination and salvage of polyethylene wedge-wire drying bed and greenhouse structure	--
Removal and disposal of engineered fill, yd^3	47,000
Area of seeding and reforestation, ac	2
Number of trees per ac	440

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be disposed of in a local landfill. The engineered fill would be removed and the site regraded, reseeded, and planted with trees.

WATER TREATMENT

Water treatment is required for water that comes into contact or could potentially come into contact with TCDD-contaminated material during remediation. The water sources requiring treatment for the different remediation alternatives for the wastewater facilities are listed in Table 6-4. Table 6-5 shows the sizes of the water treatment systems corresponding to the remedial action alternatives. The proposed treatment processes are the same as those proposed in Section 5 for the water collected during remediation of the waterways and flood plain. Refer to Section 5 for a description of the water treatment processes.

SOLIDIFICATION

Solidification processes primarily solidify wastes to produce a solid with high structural integrity. The contaminants do not necessarily interact chemically with the solidifying reagents, but are mechanically locked within the solid matrix. Thus, the potential for contaminant migration is reduced.

Solidification is proposed for the biological sludges in the aeration basin, oxidation ponds, and the abandoned sludge digester prior to ultimate disposal. The general assumptions and design criteria for solidification are presented in Table 6-6.

Bench scale tests are necessary to determine the method of solidification and the quantity and type of solidifying agent that will produce a solid with the desired properties. Previous studies with solidification indicate that the optimum solidification method varies considerably with waste type. This study assumed that a mixture of Portland cement and a sodium/silicate solution would be used to solidify the wastes. This mixture has been used by Chemfix, Inc., for solidifying sludges from wastewater treatment plants. In selecting this reagent, it was assumed that organics which would hinder the solidification process are either not present or are present at levels too low to have a significant effect. Tests would be needed to determine the optimum solidification methods and reagents.

To reduce the cost of solidification, the sludges would be dewatered to an assumed solids content of 25 percent prior to solidifying. The dewatered sludges removed from the sludge

Table 6-4
WASTE STREAMS TO REMEDIAL WATER TREATMENT PLANT
FOR REMEDIAL ALTERNATIVES FOR WASTEWATER FACILITIES

Remedial Action Alternative	Waste Streams
No Action	None
Restrict access, abandon facilities, and monitor migration	o Personnel and equiopment decontamination washwater
Local incineration[a]	o Personnel and equipment decontamination washwater
	o Decontamination washwater from cleaning contaminated facilities
	o Surface water and rainfall into impoundments
	o Leachate from solids dewatering
Remote incineration[a]	o Personnel and equipment decontamination washwater
	o Decontamination washwater from cleaning contaminated facilities
	o Surface water and rainfall into impoundments
	o Leachate from solids dewatering
Disposal in wastewater facilities	o Personnel and equipment decontamination washwater
	o Decontamination washwater from cleaning contaminated facilities
	o Surface water and rainfall into impoundments
	o Leachate from solids dewatering

Table 6-4
(continued)

Remedial Action Alternative	Waste Streams
Local disposal facility	o Personnel and equipment decontamination washwater
	o Decontamination washwater from cleaning contaminated facilities
	o Surface water and rainfall into impoundments
	o Leachate from solids dewatering
	o Leachate from disposal facility
Nonlocal disposal in RCRA facility[b]	o Personnel and equipment decontamination washwater
	o Decontamination washwater from cleaning contaminated facilities
	o Surface water and rainfall into impoundments
	o Leachate from solids dewatering

[a]Scrubber water treatment included with incineration facility.
[b]Leachate would be treated at existing disposal facility.

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Table 6-5
CAPACITY OF WATER TREATMENT SYSTEMS
WASTEWATER FACIILTIES

Remedial Action Alternative	Size of New Water Treatment Systems: Main Facility	Size of New Water Treatment Systems: Mobile Facility for Recirculation of Decontamination Washwater
No Action	--	--
Restrict access, abandon facilities, and monitor migration	--	10 gpm[a]
Local incineration	2 mgd	30 gpm
Remote incineration	2 mgd	30 gpm
Disposal in wastewater facilities	2 mgd	30 gpm
Local disposal facility	2 mgd	30 gpm
Nonlocal disposal in RCRA facility	2 mgd	30 gpm

[a]Due to high water table, may need larger treatment capacity or disposal capacity if significant removal of water is required for sewerline remediation.

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Table 6-6
DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS[a,b]
SOLIDIFICATION OF WASTEWATER SLUDGES

GENERAL ASSUMPTIONS

DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS

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Volume of Dewatered Sludges at 25 Percent Solids to be Solidified[c], yd^3	
Aeration Basin	1,550
Oxidation Ponds	39,800
Abandoned Sludge Digester	170
TOTAL	41,500
Solidifying Agent	Portland cement-sodium silicate solution
Method of incorporation	Pug mill
Mixing ratio	17 tons of solidifying agent per 100 tons of sludge
Average Production Rate, yd^3 of solidified sludge per day	80
Sludge volume increase, %	10
Final volume of solidified, dewatered sludges, yd^3	46,000
Final weight of solidified, dewatered sludges, tons	36,000

[a] A Portland cement and sodium silicate solidifying solution is compatible with contaminated wastewater sludges.

[b] A pug mill would be used to incorporate the solidifying agent in the dewatered sludges.

[c] This assumes the dewatered sludge has a density of 55 lb/ft^3.

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drying plates would be temporarily stored in a cylindrical concrete basin. A polyurethane or asphalt coating would be sprayed on the interior of the basin to seal any cracks. The sludges from the basin would then be fed to a pugmill via a conveyor belt of screw auger, depending on the consistency of the sludge. The pugmill would mix the solidifying reagents with the sludge. For the "Local Disposal" and the "Nonlocal Disposal" alternatives, the mix would then be put in semi-bulk bags and hauled to the disposal facility.

For the "Local Disposal in Wastewater Facilities" alternative, about half of the solidified sludges would have to be temporarily stored until an oxidation basin is emptied. Temporary storage is described elsewhere. Some of the solidified sludge could be discharged directly into the oxidation ponds. The time between placement of contaminated material in the oxidation ponds and capping the oxidation ponds must be minimized, though, to reduce rainfall collection in the ponds.

TEMPORARY STORAGE

The construction details of the temporary storage facility would be the same for the material from the wastewater facilities as for the material from the waterways and flood plain, which were described in Section 5.

Two 140- by 300-ft container facilities would be required for temporary storage of sediments and solidified dewatered sludges from the wastewater facilities.

One 35- by 35-ft container facility would be required for temporarily storing washed debris and infrastructure materials (for example, sewer pipe) from the wastewater facilities.

ULTIMATE WASTE MANAGEMENT--TREATMENT

The treatment technology that is most applicable to the contaminated materials associated with the wastewater treatment facilities is incineration. Two technologies are available for incineration of the wastewater treatment facilities contaminated materials; local incineration at a facility located near the wastewater treatment plant and nonlocal incineration at an existing commercial facility. The details of these technologies have been presented earlier in Section 5 under "Ultimate Waste Management--Treatment."

The assumed volumes of material that would be incinerated are given in Table 6-7. The biological sludges from the aeration basin, oxidation ponds, and abandoned sludge digester would be dewatered from an assumed 5-percent solids content to 25-percent solids. The soils and sediments from the outfall ditches and sludge drying beds were assumed to be at a

Table 6-7
VOLUMES OF MATERIAL TO BE INCINERATED
WASTEWATER FACILITIES

Source	Material Description	Quantity	
		Volume, yd^3 [a]	Weight, tons
Aeration Pond Sludges	Biological sludges[b] at 25% solids	1,550	1,150
Oxidation Pond Sludges	Biological sludges[b] at 25% solids	39,800	29,600
Outfall Ditch	Soil[c]	300	510
Abandoned Wastewater Treatment Plant	Biological sludges at 25% solids	170	130
	Sediments[c]	140	240
	Soils[c]	1,050	1,770
Sewers[c,d]		46 or 5,200	78 or 8,800
TOTAL		43,000 or 48,000 yd^3	33,500 or 42,200 tons

[a] Soil volumes are in-place volumes. Haul volumes would be approximately 25% greater than the in-place volumes.
[b] Assumed a density of 55 lb/ft^3.
[c] Assumed a density of 125 lb/ft^3.
[d] The lower quantity estimate for the sewers corresponds to Alternate A removal method--sewer cleaning--and the higher quantity estimate, Alternative B--removal of sewer and pipe zone material.

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15-percent moisture content and would not be dewatered prior to incineration. The sediments from the sewers would be dewatered prior to incineration.

ULTIMATE WASTE MANAGEMENT-DISPOSAL

Three disposal technologies were selected for further development: disposal in the existing wastewater facilities, disposal in a local facility, and disposal in a nonlocal RCRA facility. The removal and waste handling technologies for the contaminated materials in the wastewater facilities were discussed earlier in this section. This subsection discusses technologies for disposing of the dewatered and solidified contaminated material.

LOCAL DISPOSAL IN EXISTING WASTEWATER FACILITIES

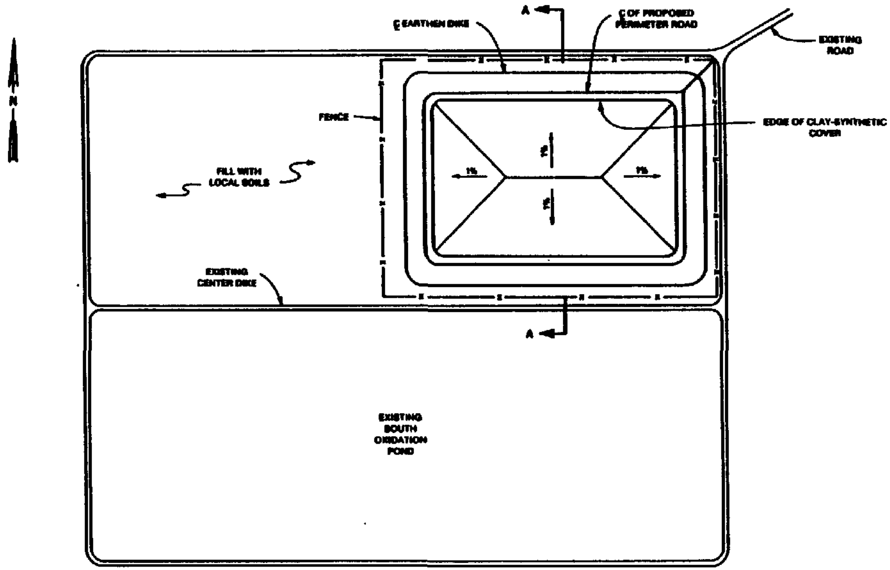
The design criteria and assumptions for this technology are given in Table 6-8. This disposal technology includes disposing contaminated materials from the aeration basin, oxidation ponds, outfall ditch, and abandoned wastewater treatment plant in a portion of the existing oxidation ponds. The sludges from these facilities would first be dewatered and solidified prior to placing in the oxidation ponds for disposal. It was assumed that the sediments and soils from the sludge drying beds and outfall ditches would not require dewatering prior to disposing in the oxidation ponds. The major features of the containment facility are shown in Figures 6-3 and 6-4. A clay-synthetic cover would be provided to divert rainfall from the contaminated area and to reduce the accessibility and exposure to the contaminated material. An earthen dike with a perimeter drain would be constructed around the oxidation ponds as a flood control measure. Monitoring wells would be provided to monitor migration of contaminants outward from the containment facility.

Also, the entire sewer system suspected to be contaminated would be plugged with a weak concrete grout. The contaminated material would become physically trapped in the sewer lines. A new sewer system would be constructed parallel to plugged sewer lines that were previously active.

The containment facility modified from the oxidation ponds is described further below.

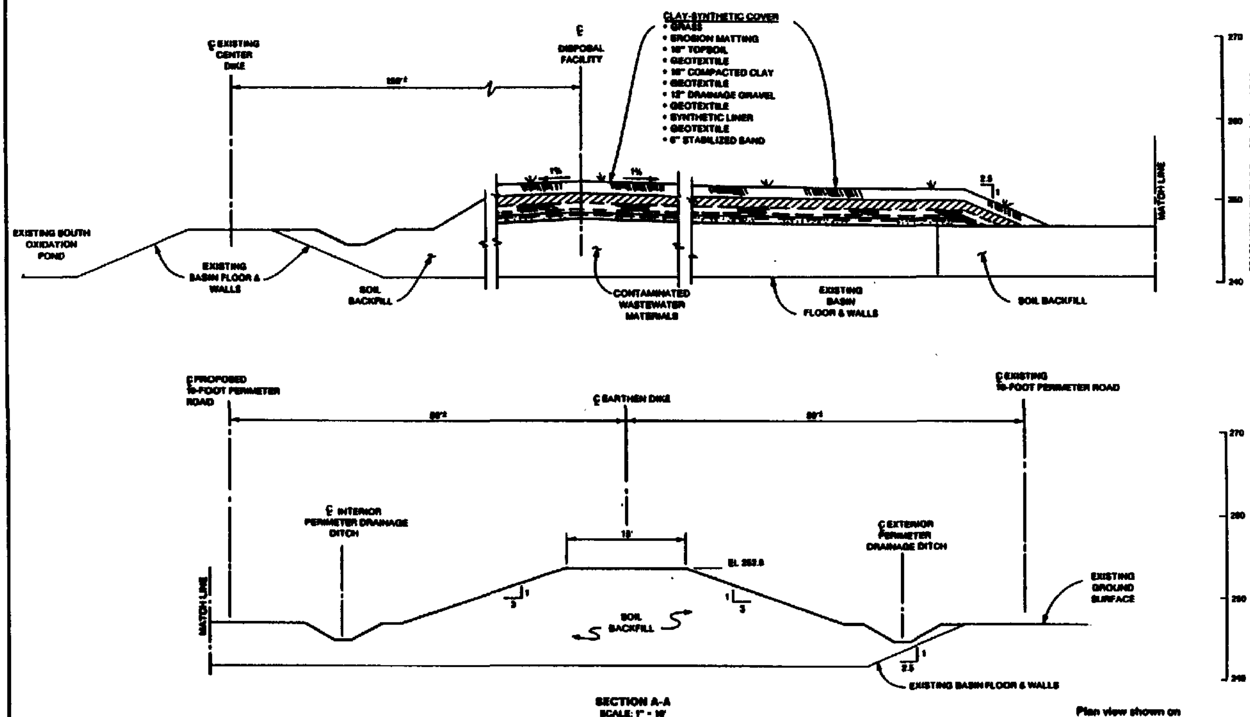
Contained Material

The total estimated volume of contaminated material from the wastewater facilities is 47,500 yd^3, and each oxidation pond can hold in excess of 210,000 yd^3. Thus, only a portion of one oxidation pond is needed for disposing of the contaminated material. An itemization of the contaminated materials is given in Table 6-8. The volumes are based on estimates presented previously in this section for removal, dewatering,



Section A-A shown on Figure 6-4

Figure 6-3
Disposal in Existing Oxidation Ponds



Plan view shown on Figure 6-3

Figure 6-4
Disposal in Existing Oxidation Ponds

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Table 6-8
DESIGN CRITERIA AND ASSUMPTIONS
DISPOSAL IN WASTEWATER FACILITIES

GENERAL ASSUMPTIONS

- o Ground is sufficiently stable for construction activities

- o A new wastewater treatment plant will be in existence which will treat the municipal wastewater currently treated at the contaminated aeration pond and oxidation basins.

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DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS

Disposal in Oxidation Ponds

Contained Material[a]

Aeration basin dewatered and solidified sludges, yd^3	1,700
Oxidation pond dewatered and solidified sludges, yd^3	44,000
Outfall ditch sediments, yd^3	300
Old Wastewater Treatment Plant	
Dewatered and solidified sludges, yd^3	190
Sediment and soil, yd^3	1,200
Allowance for miscellaneous wastes generated during remedial activities (dewatering, water treatment, decontamination, etc.), yd^3	100
TOTAL VOLUME OF CONTAMINATED MATERIAL, cy	47,500
Local soil for fill material, yd^3	166,000

Clay/Synthetic Cover

Composition	See Figure 6-4
Surface area, ac	5.6
Slope, %	1

Runoff collection System

Length of ditch, ft	2,300
Capacity of sump pump station	
flow, gpm	500
TDH, ft	10

Table 6-8
(continued)

Earthen Dike

Material	local soils
Top elevation, ft above msl	252.8[b]
Average top width, ft	15
Volume of material to construct dike, yd^3	20,200
Side slope, %	33
Length, ft	2,600
Length of exterior perimeter drainage system proposed, ft	2,800

Auxiliary facilities

Perimeter 10-foot granular base road, ft	2,300
Fence, ft	2,800

Groundwater Monitoring — Extent of groundwater monitoring cannot be determined without additional hydrogeologic information

Plug Sewer Lines

Plugging material — Weak concrete grout

Lengths of sewer lines, ft

Pipe Diameter	To Be Plugged	To Be Replaced
8"	590	590
10"	2,520	2,520
12"	2,998	2,998
15"	3,495	1,266
16"	461	-0-
18"	3,359	1,699
20"	202	202
21"	789	789
24	318	318
TOTAL LENGTH	14,700	10,400

[a] The volumes of contaminated materials to be disposed are dependent on the design criteria and assumptions given in Table 6-2 for removal of contaminated materials in the wastewater facilities, Table 6-3 for dewatering, and Table 6-6 for solidification.

[b] 100-yr flood water elevation is approximately 250.8 ft above mean sea level (msl).

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and solidification. The rest of the oxidation pond would be filled with local soil, silt, and loam material, which are assumed to be readily available.

Clay/Synthetic Cover

When placement of TCDD wastes and soil backfill in the oxidation ponds is complete, an impermeable cap would be installed. The function of the cap is to prevent percolation of rainwater into the contaminated soil, to promote drainage of rainwater off the cap while minimizing erosion, to minimize maintenance, and to provide security against public exposure to contaminated soils.

The composite cover, shown in Figure 6-4, consists of 10 layers. Side slopes are approximately 1 percent, which is sufficient for adequate drainage off the cap. The layers are described in more detail below.

A stabilized sand layer overlies the contaminated material. It functions as a collection layer for gases generated within the waste pile and provides a suitable surface on which to place subsequent layers of the cap. The sand layer is a minimum of 6 in. thick and is compacted to a high relative density.

The synthetic membrane overlying the stabilized sand is constructed either of Hypalon or CPE with a minimum thickness of 30 mils. The synthetic membrane is penetrated by vent stacks, which relieve gas that may be generated within the contaminated soils by organic decomposition. The vent stacks are bonded to the membrane and the tops are constructed with fittings to prevent admission of rainwater. The synthetic membrane is sandwiched between protective layers of nonwoven geotextile, which are a minimum of 110 mils thick.

Atop the impervious membrane is a 12-in.-thick layer of clean granular drain material. The gradation of this material is similar to standard 1-1/2-in.-thick concrete aggregate.

A compacted clay layer provides additional protection for the synthetic membrane and is itself a low-permeability barrier, reducing seepage into the drainage layer. The use of geotextile fabric over the clay reduces the topsoil cover thickness to 18 in., and facilitates their separation if re-excavated.

The topsoil is compacted and covered with erosion matting, is fertilized, and then seeded. Erosion matting helps to stabilize the topsoil until the grass cover establishes a root system. A perennial grass such as Bermuda grass, should be used.

After installation of the cover, the surface runoff, which is uncontaminated, is collected in surface trenches and collected in a sump from which it is pumped across the earthen dike to the natural drainage system.

Earthen Dike

The oxidation ponds are currently located in the 5-year flood plain. As a flood control measure, an earthen dike would be constructed around the oxidation ponds and would be designed for a 100-yr flood. Information from the USGS indicates that the 100-yr flood water elevation in this area is about 250.8 ft above msl. The proposed dike configuration is shown in Figure 6-4. The dike material would be a low permeability soil such as the local silt, loam materials. The top of the berm would be wide enough for equipment to drive on. An exterior perimeter ditch would be provided to divert surface flow away from the disposal facility.

Auxiliary Facilities

Auxiliary facilities include providing a 10-ft granular base road and a 6-ft-high, barbed-wire-topped chain-link fence around the perimeter of the capped containment.

Post-Closure Requirements

The migration of TCDD from the disposal facility would be monitored with a system of wells. The number or location of the monitoring wells cannot be determined until more hydrogeological information is obtained.

Operation and maintenance requirements would include periodic inspection of the cover for erosion, depression, animal burrows, deep-rooted plants, and other signs of actual or potential damage. The fence, road, monitoring wells, and drainage collection system would also require periodic maintenance.

LOCAL DISPOSAL

The construction of local disposal facilities for contaminated sludge/sediments from the wastewater facilities would be the same as described in Section 5 for the contaminated sediments and soils from the waterways and the flood plain. The storage facilities for the contaminated wastewater treatment facilities would be constructed in the vicinity of the wastewater treatment facilities. The design criteria and assumptions for the local disposal facility are given in Table 6-9. The layout for the disposal facilities and associated waste handling facilities is shown in Figure 6-5.

Table 6-9
DESIGN CRITERIA AND SPECIFIC ASSUMPTIONS--
LOCAL DISPOSAL--WASTEWATER FACILITIES

DESIGN CRITERIA

Number of facilities	2
Disposal capacity of each facility, yd^3	35,000
Area required, ac	2
Construction details	See Figure 5-10
Leachate treatment plant	
Proposed processes	See Figure 5-3
Capacity, mgd	2

NOTE: Ground is assumed to be sufficiently stable for construction activities.

Two 140- by 300-ft facilities with wall heights of 15 ft each would be needed for the contaminated sludge/sediments from the wastewater treatment facilities. Dewatered and solidified contaminated sludges would be transported from temporary storage or directly from the solids dewatering and solidification facilities to the disposal facilities. The containerized waste from temporary storage would be placed on flatbed trucks for transport to the facility, where it would be dumped.

It is assumed that the debris from the contaminated wastewater facilities (sewer pipe, manholes, rock) could be washed with pressurized water and delisted after washing, allowing for disposal at an existing local landfill.

NONLOCAL DISPOSAL IN RCRA FACILITY

Nonlocal disposal for the dewatered sludge/sediments from the wastewater facilities would be as described for the soils/sediments from the waterways and flood plain.

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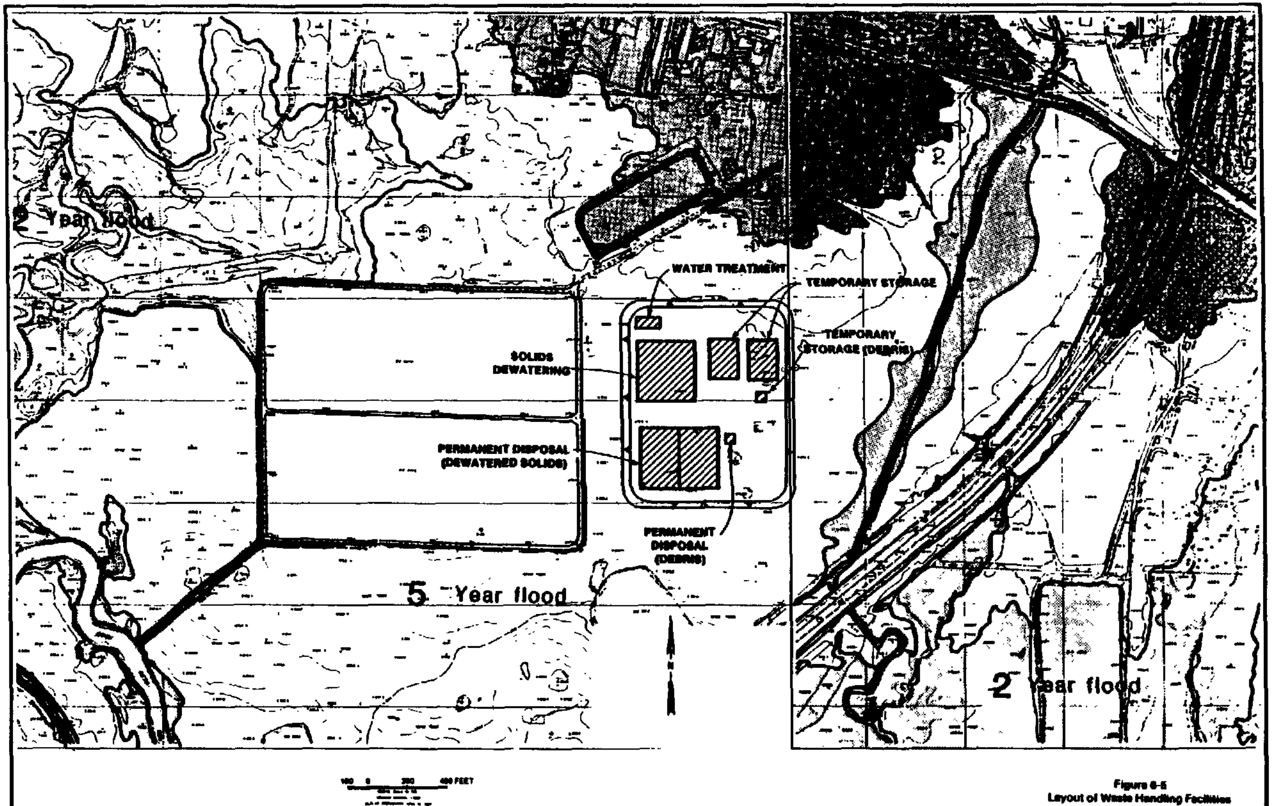

Figure 6-5
Layout of Waste Handling Facilities
Wastewater Facilities
Local Disposal

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Section 7
NONCOST EVALUATION OF REMEDIAL ACTION ALTERNATIVES

Sections 5 and 6 described in detail the remedial action alternatives developed for the contaminated materials in the waterways and flood plains and contaminated wastewater facilities. Seven remedial alternatives for the contaminated materials from the waterways and flood plains were developed for evaluation:

- A no-action alternative
- Restricting access and monitoring migration
- Rechannelization and in-situ containment of flood plain soil
- Incineration locally
- Incineration at a nonlocal facility
- Disposal in a new local hazardous waste facility
- Disposal at a nonlocal RCRA permitted existing commercial hazardous waste facility

Seven alternatives for the contaminated wastewater facilities were developed for evaluation:

- A no-action alternative
- An alternative involving restricting access to and abandoning the facilities and monitoring migration
- Incineration locally
- Incineration at a nonlocal facility
- Disposal in existing treatment facilities
- Disposal in a new RCRA-designed local hazardous waste facility
- Disposal at a nonlocal, RCRA permitted commercial hazardous waste facility.

In this section, the remedial action alternatives developed in detail are categorized based on EPA's guidelines and are evaluated in terms of the following non-cost analysis categories: technical considerations, public health effects, environmental effects, and institutional issues. This is required by the NCP.

CATEGORIZATION OF ALTERNATIVES

The remedial alternatives were categorized into the EPA categories that are based on compliance with environmental laws and regulations including CERCLA. These categories were presented in Section 3 and are repeated below.

1. Alternatives specifying offsite storage, destruction, treatment, or secure disposal of hazardous substances at a facility approved under RCRA. Such a facility must also be in compliance with all other applicable EPA standards (for example, Clean Water Act, Clean Air Act, Toxic Substances Control Act).

2. Alternatives that attain all applicable or relevant federal public health or environmental standards, guidance, or advisories.

3. Alternatives that exceed all applicable or relevant federal public health and environmental standards, guidance, and advisories.

4. Alternatives that meet the CERCLA goals of preventing or minimizing present or future migration of hazardous substances and protect human health and the environment, but do not attain the applicable or relevant standards. (This category must include an alternative that closely approaches the level or protection provided by the applicable or relevant standards).

5. No action.

The remedial alternatives are categorized in Table 7-1.

EVALUATION CRITERIA

The following paragraphs define the noncost analysis categories and criteria used in the evaluation of the remedial action alternatives.

TECHNICAL CONSIDERTAIONS

The technical suitability of an alternative is evaluated in terms of performance, reliability, implementability, and safety. These criteria are described below:

Performance. This criterion includes an evaluation of remedial action alternative effectiveness and useful life. Effectiveness is evaluated in terms of the ability of intended functions to prevent or minimize substantial danger to public health, welfare, or the environment. Useful life is the length of time the level of effectiveness can be maintained.

Table 7-1
EPA CATEGORIZATION OF REMEDIAL ALTERNATIVES

Waterways and Flood Plain Alternatives	1. RCRA Offsite Facility	2. Attains Standards	3. Exceeds Standards	4. Meets CERCLA Goals but not Standards	5. No Action
	EPA Category[a]				
No Action					X
Restrict Access and Monitor Migration				X	
In-place Containment				X	
Local Incineration		X	b	b	
Nonlocal Incineration	X	X	b	b	
Local Disposal		X	b	b	
Nonlocal Disposal in RCRA Facility	X	X	b	b	
Wastewater Facilities Alternatives					
No Action					X
Restrict Access, Abandon Facilities, and Monitor Migration				X	
Local Incineration		c	X		
Nonlocal Incineration	X	c	X		
Disposal in Wastewater Facilities				X	
Local Disposal		c	X		
Nonlocal Disposal in RCRA Facility	X	c	X		

[a] "National Oil and Hazardous Substances Contingency Plan" (U.S. EPA, November 20, 1985). An "X" signifies the category the alternative falls in.

[b] These alternatives could fall under EPA categories 3 or 4 by varying the cleanup level. The cleanup level is varied in the sensitivity analysis presented in Section 8.

[c] The extent of cleanup of the wastewater facilities assumed in this FS includes removing some soils around the treatment facilities that appear to have TCDD levels of less than 5 ppb. The action level proposed by ATSDR was 1 ppb for this area. However, the assumed increase in extent of cleanup increases the quantity of material and costs only slightly (less than 10 percent) over that for the cleanup corresponding to EPA Category 2--attains standards.

Reliability. This criterion includes consideration of operation and maintenance requirements and demonstrated and expected reliability. Operation and maintenance requirements include the frequency and complexity of necessary operation and maintenance. Demonstrated and expected reliability assess the risk and effect of failure based on proven use for similar waste and site conditions.

Implementability. This criterion considers the constructability of the remedial alternative and the time required to achieve a given level of response. The constructability, or ease of installation, is determined by considering site conditions and external factors including permits, equipment availability, and location of ultimate treatment or disposal facilities. The time required for implementation and the time it takes to see beneficial results are also implementability considerations.

Safety--The safety evaluation includes consideration of threats to the safety of nearby communities and to workers during implementation.

PUBLIC HEALTH EFFECTS

The evaluation of public health effects considers the ability for each alternative to remove or mitigate human exposures of concern.

ENVIRONMENTAL EFFECTS

The evaluation of environmental effects of the proposed alternatives considers short- and long-term beneficial and adverse effects, any adverse impacts of the alternatives, and methods for mitigating these impacts.

Institutional Issues

The evaluation of institutional issues considers the effects of federal, state, and local standards and other institutional considerations on the implementation and timing of each alternative. All laws, regulations, policies, and standards reviewed for applicability and relevance are listed in Appendix B. CERCLA Compliance with Other Environmental Statutes, published in the Federal Register, November 20, 1985, defines applicability and relevance. "Applicable" requirements are those Federal requirements that would be legally applicable whether directly or as incorporated by a federally authorized state program if the response actions were not undertaken pursuant to (CERCLA) Section 104 or 106. "Relevant and Appropriate" requirements are those federal requirements that, while not "applicable," are designed to apply to problems sufficiently similar to those encountered at CERCLA sites that their application is appropriate. Requirements may be relevant and appropriate if they would be "applicable" but for jurisdictional restrictions associated with the requirement.

EPA policy is that consideration be given to CERCLA remedial actions that comply with other federal environmental laws. However, the EPA has the option of considering and selecting a remedial action that may not fully comply with other environmental laws if the alternative still provides protection of the public health, welfare, and the environment. The basis for not meeting the requirements must be fully documented and explained in the appropriate decision documents. If applicable state and local standards are more stringent than federal standards, the EPA may select a remedy based on those more stringent standards. However, this remedy must be consistent with the federally based cost-effective remedy and, as a rule, the state must pay any additional cost associated with complying with these more stringent standards.

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Also, as stated previously, EPA's policy is to develop in detail at least one response action that meets CERCLA goals of preventing or minimizing present or future migration of hazardous substances and protect human health and the environment, but do not attain the applicable or relevant standards.

EVALUATION SUMMARY

Table 7-2 summarizes the technical criteria evaluations for remedial action alternatives for the contaminated waterways and flood plain areas. Table 7-3 summarizes the technical criteria evaluations for remedial action alternatives for the contaminated wastewater treatment facilities.

Tables 7-4 and 7-5 summarize the public health and environmental analyses for the waterways and flood plain remedial action alternatives and for the wastewater facilities remedial action alternatives, respectively.

Tables 7-6 and 7-7 summarize the institutional analyses for waterways and flood plain remedial action alternatives, and for the wastewater facilities remedial action alternatives, respectively.

Major remedial technologies that are common to more than one alternative--removal, temporary storage, water treatment, and dewatering--are evaluated separately.

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Table 7-2
TECHNICAL EVALUATION OF REMEDIAL ACTION ALTERNATIVES FOR WATERWAYS AND THE FLOOD PLAIN

Alternative	Performance	Reliability	Implementability	Safety
1. No action	No containment or destruction of TCDD-contaminated materials. TCDD-contamination of aquatic life would continue. Future transport of TCDD into the groundwater is unknown, but its rate would likely be low due to the limited mobility of bound-TCDD.	Not applicable	No implementation required. May need additional monitoring to justify no action or to determine areas for no action.	Not applicable.
2. Restrict access and monitor migration	No containment or destruction of TCDD-contaminated materials. Fence would reduce human and wildlife exposure; the effectiveness of human access restriction would depend on public acceptance of the restrictions. Contamination of fish with TCDD may continue. The contaminated fish may move downstream where waterway useage is not restricted.	The waterways could still be accessed if access barriers are bypassed or damaged. The barriers would need to be maintained. Maintaining fencing would be relatively easy, but access would need to be maintained and the frequency of maintenance would depend on effects of flooding, storms, and vandalism.	Requires miles of fencing on both sides of waterways. Access must be provided through heavily wooded areas. Constructability is relatively easy compared to Alternatives 3 through 7. Would need long-term TCDD monitoring, including sediments, aquatic life, and groundwater. Restricting access and monitoring migration would continue indefinitely. The suitability of soils for operating conventional construction equipment adjacent to the waterways, and flood plain is unknown.	Workers could potentially come in direct contact with contaminated materials.

Table 7-2
(continued)

Alternative	Performance	Reliability	Implementability	Safety
3. In-place containment	Effectively prevents direct contact by humans, wildlife, and aquatic life with contaminated sediments in waterways. Length of containment of waterway sediments is unknown. TCDD could potentially be released into the groundwater, although transport rate expected to be relatively low since TCDD would remain bound to particulates. When filling in the old channel, some contaminanted sediments may be transported downstream with the displaced water. Mitigation methods include installing a silk screen downstream to capture sediments. Geotextile and soil will provide barrier from human and some wildlife exposure. Plants and animals that penetrate the geotextile or live below the textile would be exposed to TCDD.	The soil cover over the contaminated sediments would need to be maintained until its stability reached that of area soils. The new channel must be adequately designed to achieve desired flow characteristics and to minimize bank erosion. Uncovering of contaminated soil may not be detected at times.	The stability of soils adjacent to the waterways is unknown. It may be difficult to operate conventional construction equipment on area soils. The waterways are heavily wooded and extensive tree removal would be required to provide access along the waterways and to clear areas for channel diversion. The water table in the area is high; substantial groundwater controls may be needed during channel diversion. Corps of Engineers (COE) permits for operations in waterways and wetlands would be needed prior to implementation. Would need long-term groundwater monitoring. Alternate channel could be constructed within a year. Excavation and dirt equipment is readily available. Hot and humid weather and heavy rainfalls will reduce productivity. Laying geotextile and placing topsoil around trees will lower productivity rate. Availability of topsoil for flood plain is unknown.	Construction accidents are possible during operation of heavy equipment and deforestation. Construction workers could be directly exposed to TCDD. Accidents may occur if flood plain is unable to support heavy equipment.

Table 7-2
(continued)

Alternative	Performance	Reliability	Implementability	Safety
4. Local incineration	Incineration is capable of TCDD destruction and removal efficiency (DRE) greater than 99.9999 percent. The DRE may vary with the specific unit selected. Rotary kilns have been used for PCB incineration for a number of years.	Limited incinerator operations for processing contaminated soils have shown promising DRE results but have required significant O&M. Particulate emission control and monitoring would be difficult to assure on a continuous basis; on-line TCDD analysis of stack gases is not available. TCDD is volatilized in the incinerator. Power outages, burner failure, or other circumstances could release fugitive TCDD emissions.	Ensco is scheduled to have an incinerator in place in 1986 at the Vertac property, which might be available for use. This unit has a capacity of 4 tons of soil per hour. Requires many handling and processing steps: removal operations, materials handling, water treatment systems, dewatering systems, temporary storage availability, incinerator operations, and ash delisting and disposal. Interrelated operations will affect the implementation schedule. Mobile incinerators are available but have a limited throughput. Pilot testing required to meet 99.9999 DRE in accordance with permit requirements. May be difficult to implement if operation of a local hazardous waste incinerator is opposed by the local community. Operation, maintenance, and monitoring requirements. Ash and other waste streams would need to be delisted which is time consuming and expensive. Suitability of local soils to support incineration equipment is unknown.	A reliable method for continuous on-line measurement of low levels of TCDD in the stack gas is not available. Thus workers and the public may be exposed to undetected TCDD emitted in the stack gas. Spillage of and subsequent exposure to TCDD-materials is possible when transporting TCDD-material to incinerator.

Table 7-2
(continued)

Alternative	Performance	Reliability	Implementability	Safety
5. Nonlocal incineration	Same as 4	Same as 4	In addition to the many handling and processing steps affecting implementation schedule, the time for implementation is dependent on off-site transport scheduling and on available incinerator capacity. Existing roads may have to be upgraded to accomodate the heavy traffic. The existence of and location of a suitable offsite hazardous waste incinerator are unknown.	Same as 4 except the location of the incinerator will be more remote, reducing the concern for potential impacts of air emission on local residents but increasing the possibility of spillage during transportation.
6. Local disposal	Permanent, centralized containment of TCDD contamination	RCRA type facilities have not been demonstrated for long-term effectiveness. However, the expected reliability is good due to the extent of design guidance development and the substantial increase in facility requirements compared to existing facilities. Reliability for containment would be dependent on the suitability of site conditions for allowing permanent disposal. At this time, site suitability is unknown. TCDD-contaminated sediment is a stable waste. Long-term disposal is expected to be reliable.	The facility would need to be protected from the 100-year flood elevation. A local facility may need to be raised to be at least 10 feet above the historically high water table. May need to locate at least 1/2 mile from any occupied structure. The suitability of local soils, and geology is uncertain. Long-term groundwater monitoring would be needed. Placement of contaminated materials in the facility would be difficult during inclement weather; careful coverage would be required to minimize leachate generation.	Workers could be exposed to TCDD-contaminated materials. Spillage of and subsequent exposure to TCDD-materials is possible when hauling material to disposal facility.

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Table 7-2
(continued)

Alternative	Performance	Reliability	Implementability	Safety
7. Nonlocal disposal in RCRA facility	See 6	See 6	No site currently has a RCRA Part B permit for accepting TCDD wastes. Several commercial offsite facilities are within a 500-mile radius of the site that could potentially be acceptable options. A facility permitted for TCDD disposal with adequate capacity would be needed.	Same as for 6 and additional concern of spillage of material when transporting contaminated materials up to 500 miles along public roads.
Removal (Applies to Alternatives 4 through 7)	Contaminant removal prevents substantial danger to public health, welfare, and the environment. Contamination of the waterways and flood plain is widespread and the effectiveness of removal will be limited by the extent of sampling to identify contaminated materials and to assure cleanup. Both the vacuum equipment and the conveyor system are expected to have a tight control on the depth of excavation. Removal activities would work around trees and stumps.	Vacuum dredging has been used effectively to remove sediments in water impoundments, but experience in waterways is limited. The vacuum equipment needs substantial maintenance if debris clogging is a problem or if wet clayey sediments cause clogging. Both vacuum dredging and conveyor excavation are very efficient in solids removal, i.e., emission of contaminants during excavation is unlikely.	Heavily wooded site would make equipment access and removal operations difficult along the entire waterway and in the flood plain. Removal schedule will be affected by weather conditions and potential flooding. Soils stability is not known--it may be difficult to operate heavy construction equipment in and around the waterways. The waterway areas are miles from other facilities, therefore portable electricity, lighting, decontamination stations, water treatment, etc., could be needed.	Accidents may occur when operating heavy equipment on the banks, whose stability is unknown, and when removing trees.

Table 7-2
(continued)

Alternative	Performance	Reliability	Implementability	Safety
Removal (continued)			The removal rate would be limited by the available number of properly equipped vacuum trucks and conveyor systems. Hot and humid weather would reduce worker productivity in Level C gear. The suitability of using vacuum trucks to remove contaminated waterway sediments is uncertain. The amount of water removed during dewatering of an isolated channel is extensive, and this water must be treated at a facility up to about 2.5 miles away. Dredging activities require a permit from the Corps of Engineers Dredging rate controlled by rates of subsequent activities. No long-term operation, maintenance, or monitoring requirements. Streamflow may flow through isolated channel during extreme storm events.	
Temporary storage in container facility (Applies to Alternatives 4 through 7)	Expected to provide secure containment for a short term. Containerized storage minimizes contamination of building enclosure. Containerized storage makes less efficient use of space than bulk storage.	If spillage occurs, it can be easily detected and mitigated.	Requires land space Facilities can be relatively quickly built using standard construction equipment and techniques.	Spillage of and subsequent exposure to contaminated materials is possible when hauling material to the temporary storage facility.

Table 7-2
(continued)

Alternative	Performance	Reliability	Implementability	Safety
Water treatment (Applies to Alternatives 2 through 7)	TCDD water standards for surface water discharge have not been determined. Testing would be needed to determine TCDD removal at various levels of treatment.	The system reliability could vary considerably with varying wastewater characteristics. Redundant treatment units would minimize system downtime.	Requires automatic chemical and coagulent control, backwashing mixed media filters, and changing out filter cartridges and carbon beds. Package water treatment systems are readily available. Pumping of water from the waterways to the treatment systems would require extensive pumping and pipeline system to pump from the waterway sections to a central facility. Relatively small mobile treatment systems would be needed for treating and recirculating decontamination washwater. Equipment and materials used would require decontamination or heavy disposal as a hazardous material.	Water treatment plant operators may be exposed to TCDD-contaminated materials.
Dewatering (Applies to Alternatives 4 through 7)	Testing needed to determine dewaterability of site specific soils/sediments	The variability of contaminated materials and the presence of debris could vary the dewatering rate. Dewatering of sediments in windrows has been used successfully. Building enclosure will minimize weather influences on dewatering and will help control fugitive dust emissions.	Equipment and materials used would require decontamination or disposal as a hazardous material. Requires much land area. Air monitoring required. Enclosure to extend operations and minimize fugitive emissions. Need a number of beds for sequencing of operations. Need adequate capacity for materials inventory.	Accidents with heavy equipment are possible.

Table 7-3

TECHNICAL EVALUATION OF REMEDIAL ACTION ALTERNATIVES FOR WASTEWATER FACILITIES

Alternative	Performance	Reliability	Implementability	Safety
1. No action	TCDD-contaminated materials would continue to migrate in and from the wastewater facilities. TCDD-contamination of aquatic life would continue.	Not applicable	No implementation required. May need additional monitoring to justify no action.	Not applicable.
2. Restrict access, abandon facilities, and monitor migration	Future transport of TCDD into the groundwater is unknown, but its rate would likely be low due to the limited mobility of bound-TCDD. Migration of TCDD in and from the wastewater facilities is reduced but not eliminated. The effectiveness of human access restriction would depend on public acceptance of the restrictions.	The contaminated facilities will deteriorate with time increasing the potential for TCDD-migration from the facilities.	Long-term maintenance and monitoring (including groundwater) required. Location of utilities must be determined before installing new sewer line. New treatment facilities do not have to be constructed since a new WWTP already planned by Jacksonville will be treating the sewage.	Light-construction accidents are possible.

Table 7-3
(continued)

Alternative	Performance	Reliability	Implementability	Safety
3. Local incineration	Incineration is capable of TCDD destruction and removal efficiency (DRE) greater than 99.9999 percent. The DRE may vary with the specific unit selected. Rotary kilns have been used for PCB incineration for a number of years.	Limited incinerator operations for processing contaminated soils have shown promising DRE results but have required significant O&M. Particulate emission control and monitoring would be difficult to assure on a continuous basis; on-line TCDD analysis of stack gases is not available. TCDD is volatilized in the incinerator. Power outages, burner failure, or other circumstances could release fugitive TCDD emissions.	Ensco is scheduled to have an incinerator in place in 1986 at the Vertac property which might be available for use. This unit has a capacity of 4 tons of soil per hour. Requires many handling and processing steps: removal operations, materials handling, water treatment systems, dewatering systems, temporary storage availability, incinerator operations, and ash delisting and disposal. Interrelated operations and will affect the implementation schedule. Mobile incinerators are available but have a limited throughput. Pilot testing required to meet 99.9999 DRE in accordance with permit requirements. Operation, maintenance, and monitoring requirements required for several years. High consumption of fuel. May be difficult to implement if local community opposes local incineration. Ash and other waste streams would need to be delisted which is time consuming and expensive. Suitability of local soils to support incineration equipment is unknown.	A reliable method for continuous on-line measurement of low levels of TCDD in the stack gas is not available. Thus workers and the public may be exposed to undetected TCDD emitted in the stack gas. Spillage of and subsequent exposure to TCDD-materials is possible when transporting TCDD-material to incinerator.

009804

Table 7-3
(continued)

Alternative	Performance	Reliability	Implementability	Safety
4. Nonlocal incineration	Same as 3	Same as 3	In addition to the handling and processing steps affecting implementation schedule, the time is dependent on off-site transport scheduling and availability of incinerator capacity. Existing roads may have to be upgraded to accommodate the heavy traffic. The existence of and location of a suitable offsite hazardous waste incinerator are unknown.	Same as 3 except the location of the incinerator may be more remote, reducing the concern for potential impacts of air emissions on local residents but increasing the possibility of spillage during transportation.
5. Disposal in wastewater facilities	Unknown long-term groundwater interactions with contaminated materials. Would provide centralized containment. Would provide a barrier to direct contact with contaminated material.	Cover maintenance requirements unknown. This would depend on area soils stability and stability of contained materials. Reliability for containment would be dependent on the suitability of site conditions for allowing disposal. At this time site suitability is unknown. TCDD-contaminated sediment is a stable waste. Long-term disposal is expected to be reliable.	Cover constructability uncertain due to unknowns of soils stability and ability for waste to remain stabilized in place. Need to deal with surface water runon and groundwater. Construction of new sewer line required. Long-term groundwater monitoring and maintenance needed. Facilities for disposing the material are existing and readily available. Access road to site is available but would require upgrading. A new treatment plant planned for construction will treat the municipal wastes currently treated at the aeration basin and oxidation ponds. Site is not in a residential area. Facility would need to be protected from 100-year flood.	Workers could be exposed to TCDD-contaminated material. Spillage of, and subsequent exposure to, TCDD-materials is possible.

Table 7-3
(continued)

Alternative	Performance	Reliability	Implementability	Safety
6. Local Disposal	Permanent containment of TCDD-contaminated material.	RCRA type facilities have not been demonstrated for long-term effectiveness. However, the expected reliability is good due to the extent of design guidance development and the substantial increase in facility requirements compared to existing facilities. Reliability for containment would be dependent on the suitability of site conditions for allowing permanent disposal. At this time, the overall site suitability is unknown. TCDD-contaminated sediment is a stable waste. Long-term disposal is expected to be reliable.	The facility would need to be protected from the 100-year flood elevation. A local facility may need to be raised to be at least 10 ft above the historic high water table. May need to locate at least 1/2 mile from any occupied structure. The suitability of local soils, and geology is uncertain. Long-term groundwater monitoring needed. Placement of contaminated materials in the facility would be difficult during inclement weather; careful coverage would be required to minimize leachate generation.	Workers could be exposed to TCDD-contaminated materials. Spillage of and subsequent exposure to TCDD-materials is possible when hauling material to disposal facility.

009806

Table 7-3
(continued)

Alternative	Performance	Reliability	Implementability	Safety
7. Nonlocal disposal in RCRA facility	See 6	See 6	No site currently has a RCRA Part B permit for accepting TCDD wastes. Several commercial offsite facilities are within a 500-mile radius of the site that could potentially be acceptable options. A facility permitted for TCDD disposal with adequate capacity would be needed.	Same as for 6 and a higher possibility of spillage of material when transporting contaminated materials up to 500 miles along public roads.
Removal (Applies to Alternatives 3 through 7)	Contaminant removal prevents substantial danger to public health, welfare, and the environment. Whether all material with undesirable TCDD levels is removed cannot be guaranteed.	Hydraulic flushing is a demonstrated method of sewer cleaning. Lagoon pumping is a common method of cleaning out impoundments.	Heavily wooded area around ponds would require clearing for equipment access and removal operations. Conventional construction excavation equipment could be used for removal of the contaminated sewer lines, but high water table may complicate sewer line removal. The solids removed from the surface impoundments may be quite dilute requiring additional dewatering capacity and reducing the removal rate. Removal schedule will be affected by weather conditions and potential flooding. Hot and humid weather would reduce worker productivity in Level C gear.	Flow into service lines will be prevented during flushing of sewers. Dust emissions during cleanup will be controlled. Workers could be exposed to TCDD-contaminated materials

Table 7-3
(continued)

Alternative	Performance	Reliability	Implementability	Safety
Removal (continued)			Removal rate depends on rates of subsequent processes. Materials handling is extensive. Would take 1-2 years to remove material. Sewer cleanup activities will disrupt traffic and will require temporary diversion of sewage flow. If sewer line is removed, a new sewer line must be installed.	
Temporary storage (Applies to Alternatives 3 through 7)	Expected to provide secure containment for short term. Containerized storage minimizes contamination of building enclosure. Containerized storage makes less efficient use of space than bulk storage.	If spillage occurs, it can be easily detected and mitigated.	Requires land space Facilities can be relatively quickly built using standard construction equipment and techniques.	Spillage of, and subsequent exposure to, contaminated materials is possible when hauling material to temporary storage facility.
Water treatment (Applies to Alternatives 2 through 7)	TCDD water standards for surface water discharge have not been determined. Testing would be needed to determine TCDD removal at various levels of treatment.	The system reliability could vary considerably with varying wastewater characteristics. Redundant treatment units would minimize system down time.	Requires automatic chemical and coagulent control, backwashing mixed media filters, and changing out filter cartridges and carbon beds. Package water treatment systems are readily available.	Water treatment plant operators may be exposed to TCDD-contaminated materials.

Table 7-3
(continued)

Alternative	Performance	Reliability	Implementability	Safety
			Pumping of water to the treatment systems would require pumping and pipeline systems from the various wastewater treatment facilities. Relatively small mobile treatment systems would be needed for treating and recirculating decontamination washwater. Equipment and materials used would require decontamination or disposal as a hazardous material.	
Dewatering (Applies to Alternatives 3 through 7)	Testing needed to determine dewaterability of site specific sludges and sediments.	Modular plastic filter panels allow for rapid dewatering. Building enclosure minimizes weather influences on dewatering. The variability of contaminated materials and the presence of debris could vary the dewatering rate.	Equipment and materials used would require decontamination or disposal as a hazardous material. Requires much land area. Air monitoring required. Enclosure to extend operations and minimize fugitive emissions. Need a number of beds for sequencing of operations. Need adequate capacity for materials inventory. Modular plastic filter panels are rapidly assembled.	Accidents with heavy equipment are possible.
Solidification (Applies to Alternatives 5 through 7)	Testing needed to determine solidifying chemicals and mixing ratios which will give desired results. Solidification will physically trap contaminated materials.	Solidification has been used extensively for other hazardous wastes and wastewater sludges.	Requires extensive material handling. Solidification operations will be interupted if dewatering system is interupted. Availability of local solidifying agents (e.g. portland cement) will affect ease of implementation.	Potential for workers to contact contaminants during solidification.

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0009810

Table 7-4
PUBLIC HEALTH AND ENVIRONMENTAL ANALYSIS REMEDIAL ACTION ALTERNATIVES
FOR WATERWAYS AND THE FLOOD PLAIN

Alternative	Public Health	Environment
1. No action	Potential for public exposure to TCDD. Public can access and use waterways (documented use in past including fishing, irrigation, etc.) and be exposed to TCDD-contaminated materials through direct contact, inhalation of dust, or ingestion of contaminated fish or soil.	The local ecosystem is unaltered by remedial action. Continued bioaccumulation of TCDD. Continued contaminated sediment migration downstream. The areal extent of contamination in the flood plain would increase. Some natural degradation of TCDD, e.g. UV degradation, may occur.
2. Restrict access and monitor migration	Potential for exposure to TCDD is reduced. Deters recreational use of creeks and flood plains; deters consumption of contaminated fish, a primary public health concern; deters agricultural use of creeks and floodplains. TCDD contamination remains and can bioaccumulate in fish which can still migrate to areas where access is not restricted. Transport of sediment by air is unaltered.	Restricted use may affect local irrigation. Alternative diversion points may be needed. Undesirable aesthetics impac of fence, signs, etc. along bayou. The restricted usage would apply for miles along the waterways, resulting in a substantial loss of acreage. Land use patterns may change Deed restrictions must be placed on properties to limi future access. May affect property values. Relatively minor impacts fro construction activities. Limits wildlife movement and access.

Table 7-4
(continued)

Alternative	Public Health	Environment
2. Restrict access and monitor migration (cont.)		Existing vegetation in som areas is completely removed
		Continued migration of contaminated sediment downstream and into the flood plain.
3. In-place containment	Cover acts as barrier to public exposure of contaminated materials in old waterway channel and on flood plains.	New waterway channel will provide uncontaminated environment for aquatic ecosystem.
	Reduction in potential for bioaccumulation in aquatic life that is consumed by local residents.	New waterway channel may improve flow conditions during frequent flood periods.
	Possible groundwater contamination would continue. Potential for contamination of area wells in use.	Existing aquatic ecosystem destroyed.
		Extensive deforestation for accessways and rechannelization.
	Potential for dust entrainment during construction activities and exposure to adjacent residents.	Site will be revegetated bu won't be restored to prior conditions.
		Geotextile in flood plains will be a hindrance to some biological activities.
		Short-term local jobs created and increase in the sale of goods and services to nonresidents.
		May alter land use and development pattern in the area.
		Eventually normal activitie e.g., fishing, can resume i the waterways and flood plai
		Wildlife access and movement in the flood plain will be limited during construction.

Table 7-4
(continued)

Alternative	Public Health	Environment
4. Local incineration	Destruction of TCDD eliminates potential for future human exposure to TCDD. Air emissions may present an exposure hazard if destruction of TCDD is incomplete. Additional handling of contaminated materials (moving materials to incinerator) increases the potential for worker exposure.	Destruction of TCDD eliminates the potential for release into the environment. No restrictions on future land use. Short-term local jobs create and increase in the sale of goods and services to non-residents. Public concern about having hazardous waste incinerator nearby to residential areas. Increase local energy consumption. Potential air emissions may cause degradation of local air quality. Residual ash would require removal and subsequent disposal. May temporarily alter existing land use and development patterns. Potential reduction of property values during operatic of the facility. Adverse aesthetic impacts during operation of facility Commitment of hazardous wast incinerator for several year No restrictions on future land use.

Table 7-4
(continued)

Alternative	Public Health	Environment
5. Nonlocal incineration	Destruction of TCDD eliminates potential for future human exposure to TCDD. Potential air emissions could result in exposure hazard for population near incinerator. A potential spill involving trucks carrying contaminated materials.	Destruction of TCDD eliminates the potential for future release into the environment. No restrictions on future land use. Short-term local jobs created and increase in the sale of goods and services to nonresidents. Residual ash would require removal and subsequent disposal. Commitment of hazardous waste incinerator for several years. Potential for hazardous waste spillage during hauling increases with haul distance.
6. Local disposal	Containment effectively removes materials from public exposure. Failure of disposal facility could result in exposure to adjacent residents.	Containment would remove material from environmental contact. No restrictions on future land use of the flood plain area. Short-term local jobs create and increase in the sale of goods and services to nonresidents. Failure of disposal facility could result in contaminatio of adjacent and downstream flood plains. Public concern over close proximity of disposal facility would be high. Permanently alter land use where facility is built. May permanently alter aesthetics of the area.

Table 7-4
(continued)

Alternative	Public Health	Environment
7. Nonlocal disposal in RCRA facility	Containment effectively removes materials from public exposure.	Containment would remove material from environmental contact.
	Failure of disposal facility could result in exposure to adjacent residents.	No restrictions on future land use of the flood plain area.
	Removes contaminants away from populated areas, decreasing the potential for exposure to the population.	Short-term local jobs create and increase in the sale of goods and services to non-residents.
		Failure of disposal facility could result in contamination of adjacent and downstream flood plains.
		Permanently alter land use where facility is built.
		May permanently alter aesthetics of the area.
		Potential for spillage during hauling increases with haul distance.
		Use of available commercial disposal facilities.

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Table 7-4
(continued)

Alternative	Public Health	Environment
Removal (Applies to Alternatives 4 through 7)	Future human exposure to TCDD is reduced significantly, although the removal will be based on limited sampling data and assumptions regarding the extent of contamination. TCDD levels in fish will be reduced with time and therefore risk of consumption of TCDD-fish will be reduced.	Future environmental exposur to, and migration of, TCDD i reduced significantly, although the removal will be based on limited sampling data and assumptions regarding the extent of contamination. Existing aquatic ecosystem is disrupted. Existing terrestrial ecosystem disrupted. Complete restoration of site to previous conditions is no possible. Deforestation required for access and removal operations. Hanling of contaminated mate rial to subsequent waste handling sites will increase the traffic loads on local roads substantially. Will allow future use of once-contaminated waterways and flood plain. Allows for future restoratic of existing waterway. Short-term local jobs create and increase in the sale of goods and services to nonresidents employed in remova operations. Significant truck and heavy equipment traffic along waterways will disturb wildlife.

Table 7-4
(continued)

Alternative	Public Health	Environment
Removal (Applies to Alternatives 4 through 7)	Future human exposure to TCDD is reduced significantly, although the removal will be based on limited sampling data and assumptions regarding the extent of contamination. TCDD levels in fish will be reduced with time and therefore risk of consumption of TCDD-fish will be reduced.	Future environmental exposur to, and migration of, TCDD i reduced significantly, although the removal will be based on limited sampling data and assumptions regarding the extent of contamination. Existing aquatic ecosystem is disrupted. Existing terrestrial ecosystem disrupted. Complete restoration of site to previous conditions is no possible. Deforestation required for access and removal operations. Hauling of contaminated material to subsequent waste handling sites will increase the traffic loads on local roads substantially. Will allow future use of once-contaminated waterways and flood plain. Allows for future restoratio of existing waterway. Short-term local jobs create and increase in the sale of goods and services to nonresidents employed in remova operations. Significant truck and heavy equipment traffic along waterways will disturb wildlife.

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Table 7-5
PUBLIC HEALTH AND ENVIRONMENTAL ANALYSIS REMEDIAL ACTION ALTERNATIVES
FOR WASTEWATER FACILITIES

Alternative	Public Health	Environment
1. No action	Waterway contamination would continue with potential for public exposure to TCDD. Potential for future exposure to TCDD by City sanitary personnel and local residents via direct contact or inhalation of contaminated particulates.	Continued TCDD migration into waterways, flood plain, and possibly into the groundwater. Bioaccumulation of TCDD is not reduced. The areal extent of contamination in the flood plain would increase. Some natural degradation of TCDD, e.g. UV degradation, may occur.
2. Restrict access, abandon facilities, and monitor migration	Potential for exposure to TCDD is reduced by restricting access to facilities and reducing future contamination of waterways and flood plain. Airborne sediment transport not affected. Potential for future groundwater contamination along sewers is reduced but around wastewater facilities is unaffected.	A large area of restricted land and facilities that could no longer be used. Although some monitoring wil be conducted which could indicate what, if any, futur. actions are desired, undesirable migration may occur undetected. Requires construction of new sewer lines. Relatively minor impacts fro construction activities. Wildlife movement and access around the wastewater treatment facilities would b- reduced.
3. Local incineration	Destruction of TCDD eliminates potential for future human exposure to TCDD. Air emissions may present an exposure hazard if destruction of TCDD is incomplete.	Destruction of TCDD eliminates the potential for release into the environment No restrictions on future land use. Short-term local jobs create and increase in the sale of goods and services to nonresidents.

Table 7-5
(continued)

Alternative	Public Health	Environment
3. Local Incineration (cont.)	Additional handling of contaminated materials (moving materials to incinerator) increases the potential for worker exposure.	Public concern about having hazardous waste incinerator nearby to residential areas. Temporarily increase local energy consumption. Potential air emissions may cause degradation of local air quality. Residual ash would require removal and subsequent disposal. May temporarily alter existing land use and development patterns. Potential reduction of property values during operation of the facility. Adverse aesthetic impacts during operation of facility Commitment of hazardous wast incinerator for several years. No restrictions on future land use.
4. Nonlocal incineration	Destruction of TCDD eliminates potential for future human exposure to TCDD. Potential air emissions could result in exposure hazard for population near incinerator. A potential spill involving trucks carrying contaminated materials.	Destruction of TCDD eliminates the potential for future release into the environment. Short-term local jobs created and increase in the sale of goods and services to nonresidents. Residual ash would require removal and subsequent disposal. Commitment of hazardous waste incinerator for several years.

Table 7-5
(continued)

Alternative	Public Health	Environment
4. Nonlocal incineration (cont.)		Potential for hazardous waste spillage during hauling increases with haul distance.
5. Disposal in wastewater facilities	The source of contamination of surface water systems is controlled, reducing potential public exposure. Potential for migration of TCDD particulates into potable groundwater supplies.	Containment reduces the ability of contaminants to migrate into waterway and flood plain and consequently reduces potential for future exposure to ecosystems. Potential for groundwater contamination. Loss of land use in oxidation pond area. Restoration and future use of remediated facilities is possible.
6. Local Disposal	Containment effectively removes materials from public exposure. Failure of disposal facility could result in exposure to adjacent residents.	Containment would remove material from environmental contact. No restrictions on future land use of the flood plain area. Short-term local jobs created and increase in the sale of goods and services to nonresidents. Failure of disposal facility could result in contamination of adjacent and downstream flood plains. Public concern over close proximity of disposal facility would be high. Permanently alter land use where facility is built. May permanently alter aesthetics of the area.

Table 7-5
(continued)

Alternative	Public Health	Environment
7. Nonlocal disposal in RCRA facility	Containment effectively removes materials from public exposure. Failure of disposal facility could result in exposure to adjacent residents. Removes contaminants away from populated areas, decreasing the potential for exposure to the population.	Containment would remove material from environmental contact. No restrictions on future land use of the flood plain area. Short-term local jobs create and increase in the sale of goods and services to nonresidents. Failure of disposal facility could result in contaminatic of adjacent and downstream flood plains. Permanently alter land use where facility is built. May permanently alter aesthetics of the area. Potential for spillage durin hauling increases with haul distance. Use of available commercial disposal facilities.
Removal (Applies to Alternatives 3 through 7)	Future exposure to TCDD is reduced significantly, although the removal will be based on limited sampling data and assumptions regarding the extent of contamination. TCDD levels in fish will be reduced with time and therefore, risk of consumption of TCDD-fish will be reduced.	Removal of contaminated mate rials will allow for future use of land and facilities. Short-term local jobs create and increase in the sale of goods and services to non-residents employed in remova operations. Potential for bioaccumulatic of TCDD is reduced. Potential for continued contamination of waterways and flood plain is reduced.

009820

Table 7-5
(continued)

Alternative	Public Health	Environment
Dewatering (Applies to Alternatives 3 through 7)	Additional handling of contaminated materials (leachate collection and treatment, sediment drying etc.) increases the potential for worker exposure. Dust may be generated during dewatering activities.	Land use will be altered during implementation. Leachate will be collected and treated prior to discharge to surface waters. Deforestation required to construct facility. Short-term local jobs created and increase in the sale of goods and services to nonresidents.
Water Treatment (Applies to Alternatives 2 through 7)	Treatment processes selected will reduce TCDD levels in water, reducing chance for public health hazard.	Water in contact with contaminated materials during remediation actions will be treated for TCDD removal prior to surface water discharge. Deforestation would be required for facility. Land use will be altered during implementation. Short-term local jobs created and increase in the sale of goods and services to nonresidents.
Temporary storage (Applies to Alternatives 3 through 7)	Effective short-term protection from human exposure.	Container buildings would use local land area for at least 2 years. Storage buildings would lower area aesthetics. Deforestation required to clear area. Short-term local jobs created and increase in the sale of goods and services to nonresidents.

Table 7-5
(continued)

Alternative	Public Health	Environment
Solidification (Applies to Alternatives 5 through 7)	Public could be exposed to contaminated materials and solidifying agents which are airborne during implementation.	Solidfying the contaminated material should reduce considerably the migration of TCDD. A large amount of natural resources are used for preparing the solidifying agent.

DE/VERTC2/115

Table 7-6
INSTITUTIONAL ANALYSIS
APPLICABLE/RELEVANT LAWS, REGULATIONS, POLICIES, AND STANDARDS:
REMEDIAL ACTIONS FOR WATERWAYS AND FLOODPLAIN

Law or Regulation	No Action	Restrict Access and Monitor Migration	In-place Containment	Local Incineration	Nonlocal Incineration	Local Disposal	Nonlocal Disposal
RCRA/HSWA/ Arkansas Hazardous Waste Regulations	NA; hazardous waste is not handled or disposed of	NA; hazardous waste is not handled or disposed of	NA; hazardous waste is not handled or disposed of	Relevant; local incinerator must demonstrate minimum RCRA requirements	Applicable; nonlocal incinerator must have a RCRA permit; transport requires RCRA manifest	Relevant; local disposal facility must demonstrate minimum RCRA requirements	Applicable; nonlocal disposal facility must have a RCRA permit; transport requires RCRA manifest
Permits for Structures In or Affecting Navigable Waters of the U.S.	NA; no actions affecting navigable waters	NA; no actions affecting navigable waters	Relevant; rechannelization must meet minimum standards	Relevant; removal of contaminated materials from waterways must meet minimum standards	Relevant; removal of contaminated materials from waterways must meet minimum standards	Relevant; removal of contaminated materials from waterways must meet minimum standards	Relevant; removal of contaminated materials from waterways must meet minimum standards
NPDES	NA; no water discharge	NA; no water discharge	NA; no water discharge	Applicable; NPDES permit necessary for discharge of water from dewatering process	Applicable; NPDES permit necessary for discharge of water from dewatering process	Applicable; NPDES permit necessary for discharge of water from dewatering process	Applicable; NPDES permit necessary for discharge of water from dewatering process
Response in a Flood plain or Wetlands	NA; no construction will occur	NA; no construction will occur	Applicable; construction will occur in flood plain	Applicable; excavation will occur and temporary storage and treatment facilities will be located in the flood plain	Applicable; excavation will occur and temporary storage and treatment facilities will be located in the flood plain	Applicable; excavation will occur and disposal facilities will be located in the flood plain	Applicable; excavation will occur and disposal facilities will be located in the flood plain
Intergovernmental Review of Federal Programs	Applicable, requires intergovernmental review of proposed action	Applicable; requires intergovernmental review of proposed action	Applicable; requires intergovernmental review of proposed action	Applicable; requires intergovernmental review of the proposed clean-up action	Applicable; requires intergovernmental review of the proposed clean-up action	Applicable; requires intergovernmental review of the proposed clean-up action	Applicable; requires intergovernmental review of the proposed clean-up action
DOT Regulations	NA; no transport of hazardous substances	NA; no transport of hazardous substances	NA; no transport of hazardous substances	NA; no interstate transport of hazardous substances	Applicable; transport of hazardous substances interstate must meet minimum DOT requirements	NA; no interstate transport of hazardous substances	Applicable; transport of hazardous substances interstate must meet minimum DOT requirements
U.S. EPA Groundwater Protection Strategy	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled

Table 7-6
(continued)

Law or Regulation	No Action	Restrict Access, and Monitor Migration	In-Place Containment	Local Incineration	Nonlocal Incineration	Local Disposal	Nonlocal Disposal
Conservation of Wildlife Resources	NA; no body of water will be modified	NA; no body of water will be modified	Applicable; Agency consultation required	Applicable; Agency consultation required	Applicable; Agency consultation required	Applicable; Agency consultation required	Applicable; Agency consultation requirea
Archaeo-logical and Historic Preservation Act	Unknown; existance of resources is unknown	Unknown; existance of resources is unknown	Unknown; existance of resources is unknown	Unknown; existance of resources is unknown	Unknown; existance of resources is unknown	Unknown; existance of resources is unknown	Unknown; existance of resources is unknown
Endangered Species Act	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Building Permits	NA; no new construction	NA; no new construction	Relevant; local construction	Relevant; local construction	Relevant; local construction	Relevant; local construction	Relevant; local construction
CAA/SIP/ ARKANSAS Air Code	NA; no air emissions	NA; no air emissions	NA; no air emissions	Relevant; local incinerator must demonstrate minimum requirements.	Applicable, existing incinerators are regulated at point sources if emission levels are considered significant by PED standards; nonlocal incinerator must have an Ark. Air Code permit.	NA; no air emissions	NA; no air emissions

RCRA; Resource Conservation and Recovery Act of 1976
HSWA: Hazardous and Solid Waste Amendments of 1984
CAA: Clean Air Act
SIP: State Implementation Plan
NPDES: National Pollutant Discharge Elimination System
DOT: Department of Transportation (federal)
NA: Not applicable

DE/VERTC5/068

009824

Table 7-7
INSTITUTIONAL ANALYSIS
APPLICABLE/RELEVANT LAWS, REGULATIONS, POLICIES, AND STANDARDS:
REMEDIAL ACTIONS FOR WASTEWATER FACILITIES

Law or Regulation	No Action	Restrict Access, Abandon Facilities, and Monitor Migration	Local Incineration	Nonlocal Incineration	Disposal in Wastewater Facilities	Local Disposal	Nonlocal Disposal
RCRA/HSWA/ Arkansas Hazardous Waste Regulations	NA; hazardous waste is not handled or disposed of	NA: hazardous waste is not handled or disposed of	Relevant; local incinerator must demonstrate minimum RCRA requirements	Applicable; non-local facility must have a RCRA permit; transport requires RCRA manifest	Relevant; local facility must demonstrate minimum RCRA requirements	Relevant; local facility must demonstrate minimum RCRA requirements	Applicable; nonlocal facility must have a RCRA permit; transport requires RCRA manifest
Permits for Structures In or Affecting Navigable Waters of the U.S.	NA; no actions affecting navigable waters	NA; no actions affecting navigable waters	Relevant; removal of soils and sediments must meet minimum standards	Relevant; removal of soils and sediments must meet minimum standards	Relevant; removal of soils and sediments must meet minimum standards	Relevant; removal of soils and sediments must meet minimum standards	Relevant; removal of soils and sediments must meet minimum standards
NPDES	NA; no water discharge	NA; no water discharge	Applicable; NPDES permit necessary for discharge of water from dewatering process	Applicable; NPDES permit necessary for discharge of water from dewatering process	Applicable; NPDES permit necessary for discharge of water from dewatering process	Applicable; NPDES permit necessary for discharge of water from dewatering process	Applicable; NPDES permit necessary for discharge of water from dewatering process
Response in a Flood plain or Wetlands	NA; no construction will occur	Applicable; construction will occur in the flood plain	Applicable; removal will occur and temporary storage and treatment facilities will be located in the flood plain.	Applicable; removal will occur and temporary storage and treatment facilities will be located in the flood plain.	Applicable; removal will occur and disposal facilities will be located in the flood plain.	Applicable; removal will occur and disposal facilities will be located in the flood plain.	Applicable; removal will occur and disposal facilities will be located in the flood plain.
Intergovernmental Review of Federal Programs	Applicable; requires intergovernmental review of proposed action	Applicable; requires intergovernmental review of proposed action	Applicable; requires intergovernmental review of proposed clean-up action	Applicable; requires intergovernmental review of proposed clean-up action	Applicable; requires intergovernmental review of proposed clean-up action	Applicable; requires intergovernmental review of proposed clean-up action	Applicable; requires intergovernmental review of proposed clean-up action
DOT regulations	NA; no transport of hazardous substances	NA; no transport of hazardous substances	NA; no interstate transport of hazardous materials	Applicable; transport of hazardous substances interstate must meet minimum DOT requirements	NA; no interstate transport of hazardous substances	NA; no interstate transport of hazardous substances	Applicable; transport of hazardous substances interstate must meet minimum DOT requirements
U.S. EPA Groundwater Protection Strategy	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled	Applicable; groundwater has not yet been sampled

Table 7-7
(continued)

Law or Regulation	No Action	Restrict Access, Abandon Facilities, and Monitor Migration	Local Incineration	Non-Local Incineration	Disposal in Wastewater Facilities	Local Disposal	Non-Local Disposal
Conservation of Wildlife Resources	NA; no body of water will be modified	NA; no body of water will be modified	Applicable; Agency consultation required	Applicable; Agency consultation required	Applicable; Agency consultation required	Applicable; Agency consultation required	Applicable; Agency consultation required
Archaeological and Historic Preservation Act	Unknown; existence of resources is unknown	Unknown; existence of resources is unknown	Unknown; existence of resources is unknown	Unknown; existence of resources is unknown	Unknown; existence of resources is unknown	Unknown; existence of resources is unknown	Unknown; existence of resources is unknown
Endangered Species Act	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Building Permits	NA; no new construction	NA; no new construction	Relevant; local construction	Relevant; local construction	Relevant; local construction	Relevant; local construction	Relevant; local construction
CAA/SIP/ Arkansas Air Code	NA; no air emissions	NA; no air emissions	Relevant; local incinerator must demonstrate minimum requirements	Applicable; existing incinerators are regulated as point sources if emission levels are considered significant by PSD standards; non-local incinerator must have an Ark. Air Code permit	NA; no air emissions	NA; no air emissions	NA; no air emissions

RCRA: Resource Conservation and Recovery Act of 1976
HSWA: Hazardous and Solid Waste Amendments of 1984
CAA: Clean Air Act
SIP: State Implementation Plan
NPDES: National Pollutant Discharge Elimination System
DOT: Department of Transportation (federal)
NA: Not Applicable

DE/VERTC5/067

009826

Section 8

COST ANALYSIS AND IMPLEMENTATION SCHEDULE

COST ANALYSIS

The NCP requires that comparative cost estimates be developed for remedial action alternatives. The capital cost and present worth estimates for each of the alternatives are given in Tables 8-1 and 8-2 for the waterways and the flood plain and the wastewater facilities, respectively. The cost summaries for each alternative except the No Action alternative are presented in Tables 8-3 through 8-14. Detailed cost estimates are given in Appendix C. Changes in the assumptions, design criteria, waste volumes, site conditions, or contingencies for an alternative will affect the estimated costs.

The cost estimates are order-or-magnitude estimates as defined by the American Association of Cost Engineers. These estimates are defined as follows:

> <u>Order-of-Magnitude Estimate</u>
>
> An approximate estimate made without detailed engineering data. Some examples would be: an estimate from cost versus capacity curves, an estimate using scaleup or scaledown factors, and an approximate ratio estimate. It is normally expected that an estimate of this type would be accurate within plus 50 percent or minus 30 percent.

The capital costs presented in the cost tables include the operation and maintenance costs that are required to carry out the initial remedial actions. O&M costs presented are those costs incurred after the initial remedial action (installation of fences, signs, and wells; containment; removal and storage or incineration) that are necessary to ensure continued effectiveness of a remedial action and achievement of its objectives. Examples of operation and maintenance costs are ongoing site monitoring and maintenance of facilities to restrict access.

Contingency allowances have also been included in the cost estimates. These allowances account for normal process refinement and unknown site conditions. Allowances are also included for engineering and administrative costs. Allowances for inflation, additional contaminated material, and abnormal technical difficulties are not accounted for in the contingency. The indirect benefits and costs of items that are not easily quantifiable, such as lost revenue if fishing is banned in the Bayou, are not included in the cost analyses.

Table 8-1
COST SUMMARY
WATERWAYS AND FLOOD PLAIN
REMEDIAL ALTERNATIVES

	Capital Cost $ million	Present Worth $ million
No Action	$ 0	$ 0
Restrict Access and Monitor Migration	1.6	1.4
In-Place Containment	4.6	3.8
Local Incineration	240	160
Nonlocal Incineration	220	140
Local Disposal	65	49
Nonlocal Disposal	79	55

Notes: Discount rate = 10 percent.
Costs in 1986 dollars.

DE/VERTC6/021

Table 8-2
COST SUMMARY
WASTEWATER FACILITIES
REMEDIAL ALTERNATIVES

	Alternative A		Alternative B	
	Capital Cost $ million	Present Worth $ million	Capital Cost $ million	Present Worth $ million
No action	$ 0	$ 0	$ 0	$ 0
Restrict Access, Abandon Facilities, and Monitor Migration	1.9	1.7	NA	NA
Local Incineration	120	83	140	97
Nonlocal Incineration	110	78	130	90
Disposal in Wastewater Facilities	57	40	NA	NA
Local Disposal	61	43	63	48
Nonlocal Disposal	71	45	76	53

Notes: Discount rate = 10 percent.
Costs in 1986 dollars.
Alternative A--Cleaning sewer line.
Alternative B--Removal of sewer and pipe zone material.

DE/VERTC6/022

009829

Table 8-3
COST SUMMARY
WATERWAYS AND FLOOD PLAIN
RESTRICT ACCESS AND MONITOR MIGRATION

	Percent	Capital Cost $ million	O&M Cost $ million	Present Worth $ million
REMEDIAL TECHNOLOGIES/ FACILITIES				
Restrict Access and Monitor Migration		$0.68	$0.03	$0.65
Mobile Water Treatment Facility		0.25		0.21
SUBTOTAL		0.93	0.03	
Mobilization, Bonds, & Insurance	5.00	0.05		0.03
Health & Safety	7.00	0.07		0.05
CONSTRUCTION SUBTOTAL		1.04		
Bid Contingencies	15.00	0.16		0.12
Scope Contingencies	10.00	0.10		0.08
CONSTRUCTION TOTAL		1.30		
Permitting & Legal	5.00	0.07		0.05
Services During Construction	7.00	0.09		0.07
TOTAL IMPLEMENTATION COST		1.46		
Engineering Design Cost (% of Construction Total)	10.00	0.13		0.12
TOTAL COST		$1.6		$1.4

Notes: Discount rate = 10 percent
Costs in 1986 dollars.

DE/VERTC6/023

0038900

Table 8-4
COST SUMMARY
WATERWAYS AND FLOOD PLAIN
IN-PLACE CONTAINMENT

	Percent	Capital Cost $ million	O&M Cost $ million	Present Worth $ million
REMEDIAL ACTIONS/ FACILITIES		$1.79	$0.03	$1.43
Rechannelize Waterways				
Cover Flood Plains		0.61	0.03	0.63
Mobile Water Treatment Facility		0.25		0.21
SUBTOTAL		2.64	0.06	
Mobilization, Bonds, & Insurance	7.00	0.18		0.14
Health & Safety	7.00	0.18		0.14
CONSTRUCTION SUBTOTAL		3.01		
Bid Contingencies	15.00	0.45		0.34
Scope Contingencies	10.00	0.30		0.23
CONSTRUCTION TOTAL		3.76		
Permitting & Legal	5.00	0.19		0.14
Services during construction	7.00	0.26		0.20
TOTAL IMPLEMENTATION COST		4.22		
Engineering Design Cost (% of Construction Total)	10.00	0.38		0.34
TOTAL COST		$4.6		$3.8

Notes: Discount rate = 10 percent.
Costs in 1986 dollars.

DE/VERTC6/024

Table 8-5
COST SUMMARY
WATERWAYS AND FLOOD PLAIN
LOCAL INCINERATION

	Percent	Capital Cost $ million	O&M Cost $ million	Present Worth $ million
REMEDIAL TECHNOLOGIES/ FACILITIES				
Remove Material		$9.09	$0.02	$5.64
Sediment Dewatering		1.92	0.00	1.44
Fixed Water Treatment Plant		3.93	0.00	2.95
Temporary Storage		13.51	0.00	8.39
Local Incineration		92.39	0.00	57.36
Mobile Water Treatment Facility		0.25		0.19
SUBTOTAL		121.08	0.02	
Mobilization, Bonds, & Insurance	5.00	6.05		3.76
Health & Safety	7.00	8.48		5.26
CONSTRUCTION SUBTOTAL		135.61		
Bid Contingencies	15.00	20.34		12.63
Scope Contingencies	30.00	40.68		25.26
CONSTRUCTION TOTAL		196.63		
Permitting & Legal	7.00	13.76		8.55
Services During Construction	7.00	13.76		8.55
TOTAL IMPLEMENTATION COST		224.16		
Engineering Design Cost (% of of Construction Total)	10.00	19.66		17.88
TOTAL COST		$240		$160

Notes: Discount rate = 10 percent.
Costs in 1986 dollars.

DE/VERTC6/025

Table 8-6
COST SUMMARY
WATERWAYS AND FLOOD PLAIN
NONLOCAL INCINERATION

	Percent	Capital Cost $ million	O&M Cost $ million	Present Worth $ million
REMEDIAL TECHNOLOGIES/ FACILITIES				
Remove Material		$9.09	$0.02	$5.64
Sediment Dewatering		1.92	0.00	1.19
Fixed Water Treatment Plant		3.93	0.00	2.95
Temporary Storage		13.51	0.00	8.39
Nonlocal Incineration		94.72	0.00	58.81
Mobile Water Treatment Facility		0.25		0.19
SUBTOTAL		123.41	0.02	
Mobilization, Bonds, & Insurance	4.00	4.94		3.07
Health & Safety	7.00	8.64		5.36
CONSTRUCTION SUBTOTAL		136.99		
Bid Contingencies	20.00	27.40		17.01
Scope Contingencies	15.00	20.55		12.76
CONSTRUCTION TOTAL		184.93		
Permitting & Legal	5.00	9.25		5.74
Services During Construction	5.00	9.25		5.74
TOTAL IMPLEMENTATION COST		203.42		
Engineering Design Cost (% of Construction Total)	10.00	18.49		16.81
TOTAL COSTS		$220		$140

Notes: Discount rate = 10 percent.
Costs in 1986 dollars.

DE/VERTC6/026

Table 8-7
COST SUMMARY
WATERWAYS AND FLOOD PLAIN
LOCAL DISPOSAL

	Percent	Capital Cost $ million	O&M Cost $ million	Present Worth $ million
REMEDIAL TECHNOLOGIES/ FACILITIES				
Remove Material		$9.09	$0.02	$6.21
Sediment Dewatering		1.92	0.00	1.31
Fixed Water Treatment Plant		3.93	0.00	2.95
Temporary Storage		11.96	0.00	8.17
Local Disposal		7.72	0.40	7.99[a]
Mobile Water Treatment Facility		0.25		0.19
SUBTOTAL		34.86	0.41	
Mobilization, Bonds, & Insurance	5.00	1.74		1.19
Health & Safety	7.00	2.44		1.67
CONSTRUCTION SUBTOTAL		39.05		
Bid Contingencies	15.00	5.86		4.00
Scope Contingencies	20.00	7.81		5.33
CONSTRUCTION TOTAL		52.71		
Permitting & Legal	7.00	3.69		2.52
Services During Construction	7.00	3.69		2.52
TOTAL IMPLEMENTATION COST		60.10		
Engineering Design Cost (% of Construction Total)	10.00	5.27		4.79
TOTAL COST		$65		$49

[a]Includes a present worth allowance for a disposal facility replacement of $0.18 million, which assumes a facility life of 30 yr.

Notes: Discount rate = 10 percent.
Costs in 1986 dollars.

DE/VERTC6/027

009834

Table 8-8
COST SUMMARY
WATERWAYS AND FLOOD PLAIN
NONLOCAL STORAGE

	Percent	Capital Cost $ million	O&M Cost $ million	Present Worth $ million
REMEDIAL TECHNOLOGIES/ FACILITIES				
Remove Material		$9.09	$0.02	$6.21
Sediment Dewatering		1.92	0.00	1.31
Fixed Water Treatment Plant		3.93	0.00	2.95
Temporary Storage		11.96	0.00	8.17
Nonlocal Storage		16.55	0.00	11.31
Mobile Water Treatment Facility		0.25		0.19
SUBTOTAL		43.70	0.02	
Mobilization, Bonds, & Insurance	4.00	1.75		1.19
Health & Safety	7.00	3.06		2.09
CONSTRUCTION SUBTOTAL		48.51		
Bid Contingencies	20.00	9.70		6.63
Scope Contingencies	15.00	7.28		4.97
CONSTRUCTION TOTAL		65.49		
Permitting & Legal	5.00	3.27		2.24
Services During Construction	5.00	3.27		2.24
TOTAL IMPLEMENTATION COST		72.03		
Engineering Design Cost (% of Construction Total)	10.00	6.55		5.95
TOTAL COST		$79		$55

Notes: Discount rate = 10 percent.
Costs in 1986 dollars.

DE/VERTC6/028

Table 8-9
COST SUMMARY
WASTEWATER FACILITIES
RESTRICT ACCESS, ABANDON FACILITIES, AND MONITOR MIGRATION

	Percent	Capital Cost $ million	O&M Cost $ million	Present Worth $ million
REMEDIAL TECHNOLOGIES/ FACILITIES				
Restrict Access, Abandon Facilities, and Monitor Migration		$0.89	$0.03	$0.82
Mobile Water Treatment Facility		0.25		0.21
SUBTOTAL		1.14		
Mobilization, Bonds, & Insurance	5.00	0.06		0.04
Health & Safety	7.00	0.08		0.06
CONSTRUCTION SUBTOTAL		1.27		
Bid Contingencies	15.00	0.19		0.15
Scope Contingencies	10.00	0.13		0.10
CONSTRUCTION TOTAL		1.59		
Permitting & Legal	5.00	0.08		0.06
Services During Construction	7.00	0.11		0.09
TOTAL IMPLEMENTATION COST		1.78		
Engineering Design Cost (% of Construction)	10.00	0.16		0.14
TOTAL COST		$1.9		$1.7

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Notes: Discount rate = 10 percent.
Costs in 1986 dollars.

DE/VERTC6/029

Table 8-10
COST SUMMARY
WASTEWATER FACILITIES
LOCAL INCINERATION

		Alternative A			Alternative B		
	Percent	Capital Cost	O&M Cost	Present Worth	Capital Cost	O&M Cost	Present Worth
REMEDIAL TECHNOLOGIES/ FACILITIES							
Remove Matl/ Treatment Facilities		$1.05	$0.00	$0.72	$1.05	$0.00	$0.72
Remove Matl/ Sewers	0.64	0.70	0.01	0.48	1.13	0.00	0.77
Sludge De-watering		6.80	0.00	4.64	6.80	0.00	4.64
Fixed Water Treatment Plant		3.44	0.00	2.58	3.44	0.00	2.58
Temporary Storage		11.29	0.00	7.71	12.17	0.00	8.31
Local Incineration		35.25	0.00	24.08	44.02	0.00	30.06
Mobile Water Treatment Facility		0.25		0.19	0.25		0.19
SUBTOTAL		58.78	0.01		68.86	0.00	
Mobilization, Bonds, & Insurance	5.00	2.94		2.01	3.44		2.35
Health & Safety	7.00	4.11		2.81	4.82		3.29
CONSTRUCTION SUBTOTAL		65.84			77.12		
Bid Contingencies	15.00	9.88		6.75	11.57		7.90
Scope Contingencies	30.00	19.75		13.49	23.14		15.80
CONSTRUCTION TOTAL		95.47			111.83		

Table 8-10
(continued)

	Percent	Alternative A Capital Cost	Alternative A O&M Cost	Alternative A Present Worth	Alternative B Capital Cost	Alternative B O&M Cost	Alternative B Present Worth
Permitting & Legal	7.00	6.68		4.56	7.83		5.35
Services During Construction	7.00	6.68		4.56	7.83		5.35
TOTAL IMPLEMENTATION COST		108.83			127.48		
Engineering Design Cost (% of Construction Total)	10.00	9.55		8.68	11.18		10.17
TOTAL COST		$120	–	$83	$140		$97

NOTES: Discount rate = 10 percent.
Costs in 1986 dollars.
Alternative A--Cleaning sewer line.
Alternative B--Removal of sewer and pipe zone material.

DE/VERTC6/030

Table 8-11
COST SUMMARY
WASTEWATER FACILITIES
NONLOCAL INCINERATION

		Alternative A			Alternative B		
	Percent	Capital Cost	O&M Cost	Present Worth	Capital Cost	O&M Cost	Present Worth
REMEDIAL TECHNOLOGIES/ FACILITIES							
Remove Matl/ Treatment Facilities		$1.05	$0.00	$0.72	$1.05	$0.00	$0.72
Remove Matl/ Sewers		0.70	0.01	0.48	1.13	0.00	0.77
Sludge De-watering		6.80	0.00	4.64	6.80	0.00	4.64
Fixed Water Treatment Plant		3.44	0.00	2.58	3.44	0.00	2.58
Temporary Storage		11.29	0.00	7.71	12.17	0.00	8.31
Nonlocal Incineration		37.87	0.00	25.86	46.59	0.00	31.82
Mobile Water Treatment Facility		0.25		0.19	0.25		0.19
SUBTOTAL		61.40	0.01		71.44	0.00	
Mobilization, Bonds, & Insurance	4.00	2.46		1.68	2.86		1.95
Health & Safety	7.00	4.30		2.94	5.00		3.42
CONSTRUCTION SUBTOTAL		68.15			79.30		
Bid Contingencies	20.00	13.63		9.31	15.86		10.83
Scope Contingencies	15.00	10.22		6.98	11.89		8.12
CONSTRUCTION TOTAL		92.00			107.05		

Table 8-11
(continued)

	Percent	Alternative A Capital Cost	Alternative A O&M Cost	Alternative A Present Worth	Alternative B Capital Cost	Alternative B O&M Cost	Alternative B Present Worth
Permitting & Legal	5.00	4.60		3.14	5.35		3.66
Services During Construction	5.00	4.60		3.14	5.35		3.66
TOTAL IMPLEMENTATION COST		101.20			117.75		
Engineering Design Cost (% of Construction Total)	10.00	9.20		8.36	10.70		9.73
TOTAL COST		$110		$78	$130		$90

NOTES: Discount rate = 10 percent.
Costs in 1986 dollars.
Alternative A--Cleaning sewer line.
Alternative B--Removal of sewer and pipe zone material.

DE/VERTC6/031

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Table 8-12
COST SUMMARY
WASTEWATER FACILITIES
DISPOSAL IN WASTEWATER FACILITIES

	Percent	Capital Cost $ million	O&M Cost $ million	Present Worth $ million
REMEDIAL TECHNOLOGIES/ FACILITIES				
Remove Matl/Treatment Facilities		$1.05	$0.00	$0.72
Sludge Dewatering		6.80	0.00	4.64
Fixed Water Treatment Plant		3.44	0.00	2.58
Solidification		2.58	0.00	1.76
Temporary Storage		11.29	0.00	7.71
Disposal in Oxidation Ponds		3.67	0.02	2.35
Plugging of Sewers		1.06	0.00	0.76
Mobile Water Treatment Facility		0.25		0.19
SUBTOTAL		30.14		
Mobilization, Bonds, & Insurance	5.00	1.51		1.03
Health & Safety	7.00	2.11		1.44
CONSTRUCTION SUBTOTAL		33.76		
Bid Contingencies	15.00	5.06		3.46
Scope Contingencies	20.00	6.75		4.61
CONSTRUCTION TOTAL		45.58		
Permitting & Legal	7.00	3.19		2.18
Services During Construction	7.00	3.19		2.18
TOTAL IMPLEMENTATION COST		51.96		
Engineering Design Cost (% of Construction Total)	10.00	4.56		4.14
TOTAL COST		$57		$40

Notes: Discount rate = 10 percent.
Costs in 1986 dollars.

DE/VERTC6/032

Table 8-13
COST SUMMARY
WASTEWATER FACILITIES
LOCAL DISPOSAL

	Percent	Alternative A Capital Cost ($1,000)	Alternative A O&M Cost ($1,000)	Alternative A Present Worth ($1,000)	Alternative B Capital Cost ($1,000)	Alternative B O&M Cost ($1,000)	Alternative B Present Worth ($1,000)
REMEDIAL TECHNOLOGIES/ FACILITIES							
Remove Matl/ Treatment Facilities		$1.05	$0.00	$0.72	$1.05	$0.00	$0.72
Remove Matl/ Sewers		0.70	0.01	0.48	1.13	0.00	0.77
Sludge De-watering		6.80	0.00	4.64	6.80	0.00	4.64
Fixed Water Treatment Plant		3.44	0.00	2.58	3.44	0.00	2.58
Solidification		2.58	0.00	1.76	2.58	0.00	1.76
Temporary Storage		11.29	0.00	7.71	12.17	0.00	8.31
Local Disposal		6.36	0.40	7.21[a]	6.40	0.40	7.24[a]
Mobile Water Treatment Facility		0.25		0.19	0.25		0.19
SUBTOTAL		32.47	0.41		33.82	0.40	
Mobilization, Bonds, & Insurance	5.00	1.62		1.38	1.69		1.15
Health & Safety	7.00	2.27		1.81	2.37		1.62
CONSTRUCTION SUBTOTAL		36.37			37.88		
Bid Contingencies	15.00	5.46		3.17	5.68		3.88
Scope Contingencies	20.00	7.27		3.53	7.58		5.17
CONSTRUCTION TOTAL		49.10			51.13		

Table 8-13
(continued)

	Percent	Alternative A Capital Cost	Alternative A O&M Cost	Alternative A Present Worth	Alternative B Capital Cost	Alternative B O&M Cost	Alternative B Present Worth
Permitting & Legal	7.00	3.44		2.44	3.58		2.44
Services During Construction	7.00	3.44		2.44	3.58		2.44
TOTAL IMPLEMENTATION COST		55.97			58.29		
Engr. Design Cost (% of Constr. Total)	10.00	4.91		3.02	5.11		4.65
TOTAL COST		$61		$43	$63		$48

[a]Includes a present worth allowance for disposal facility replacement of $0.18 million which assumes a facility life of 30 yr.

Notes: Discount rate = 10 percent.
Costs in 1986 dollars.
Alternative A--Cleaning sewer line.
Alternative B--Removal of sewer and pipe zone material.

DE/VERTC6/033

Table 8-14
COST SUMMARY
WASTEWATER FACILITIES
NONLOCAL DISPOSAL

	Percent	Alternative A Capital Cost ($1,000)	Alternative A O&M Cost ($1,000)	Alternative A Present Worth ($1,000)	Alternative B Capital Cost ($1,000)	Alternative B O&M Cost ($1,000)	Alternative B Present Worth ($1,000)
REMEDIAL TECHNOLOGIES/ FACILITIES							
Remove Matl/ Treatment Facilities		$1.05	$0.00	$0.72	$1.05	$0.00	$0.72
Remove Matl/ Sewers		0.70	0.01	0.48	1.13	0.00	0.77
Sludge De-watering		6.80	0.00	4.64	6.80	0.00	4.64
Fixed Water Treatment Plant		3.44	0.00	2.58	3.44	0.00	2.58
Solidification		2.58	0.00	1.76	2.58	0.00	1.76
Temporary Storage		11.29	0.00	7.71	12.17	0.00	8.31
Nonlocal Disposal		13.47	0.00	9.20	14.57	0.00	9.95
Mobile Water Treatment Facility		0.25		0.19	0.25		0.19
SUBTOTAL		39.58	0.01		41.99	0.00	
Mobilization, Bonds, & Insurance	4.00	1.58		1.35	1.68		1.15
Health & Safety	7.00	2.77		2.09	2.94		2.01
CONSTRUCTION SUBTOTAL		43.94			46.61		
Bid Contingencies	20.00	8.79		3.61	9.32		6.37
Scope Contingencies	15.00	6.59		3.38	6.99		4.78
CONSTRUCTION TOTAL		59.31			62.92		

009844

Table 8-14
(continued)

		Alternative A			Alternative B		
	Percent	Capital Cost	O&M Cost	Present Worth	Capital Cost	O&M Cost	Present Worth
Permitting & Legal	5.00	2.97		2.20	3.15		2.15
Services During Construction	5.00	2.97		2.20	3.15		2.15
TOTAL IMPLEMENTATION COST		65.25			69.22		
Engineering Design Cost (% of Construction Total)	10.00	5.93		3.26	6.29		5.72
TOTAL COST		$71		$45	$76		$53

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Notes: Discount rate = 10 percent.
Costs in 1986 dollars.
Alternative A--Cleaning sewer line.
Alternative B--Removal of sewer and pipe zone material.

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The feasibility-level cost estimates shown have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope, final project schedule, the firm selected for final engineering design, and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

SOURCES

The sources used in developing the cost estimates included the following:

- Richardsons--Process Plant Construction Estimating Standards, 1985.
- Means Construction Cost Data, 1985.
- Marshall Evaluation Services, 1986.
- CH2M HILL REM/FIT Cost Estimating Guide, prepared by Mike Morrison and Greg Peterson, July 1985.
- "Love Canal Sewers and Creeks, Remedial Alternatives Evaluation and Risk Assessment," an EPA Region II feasibility study, March 1985.
- "Feasibility Study of Final Remedial Actions for the Minker/Stout site," Second Agency Review Draft submitted to EPA Region VII in February 1986.
- "Draft Focused Feasibility Study Report for Romaine Creek, Missouri," submitted to EPA Region VII, July 1985.
- "Draft Feasibility Study Report for Cecil Lindsey. Site, Newport, Arkansas," EPA Region VI Report, June 3, 1985.
- Cost information from vendors.
- Remedial action costs incurred at Missouri sites.

ASSUMPTIONS

The general assumptions made in preparing these cost estimates include the following:

1. Personnel exposed to the TCDD-contaminated soil would wear Level C personal protective gear. Individuals working around the soil but not directly exposed to it would wear Level D gear. The use of Levels C and D personnel protective gear will reduce worker efficiency, shorten summer work periods, and include other health and safety requirements. For Level C, these effects have been reported to increase labor requirements by at least three times over standard conditions.

2. Community relations planning would be included for all alternatives to keep the community informed of progress at the facility and of any potential hazards that may exist.

3. Stringent dust control would be required for any alternative that involves significant soil disruption or handling. Dust control would be provided by water spray.

4. Unless otherwise noted, costs are for the Jacksonville, Arkansas, area for the year 1986.

5. The discount rate for economic analyses, 10 percent, was used in determining the present worth of each of the alternatives. This is the discount rate stated to be used in the Guidance of Feasibility Studies under CERCLA (U.S. EPA, April 1985).

6. The U.S. EPA Guidance on Feasibility Studies under CERCLA (U.S. EPA, April 1985) states that the economic analysis period should not exceed 30 yr. Thirty years was the economic period used. The estimated remedial costs for most of the alternatives occurred within this 30-yr period. However, the local disposal alternatives are expected to require replacement of the major disposal features periodically, assumed to be 30 yr. These replacement costs were incorporated into the economic analysis.

7. The first year of the economic analysis is assumed to be the year when design of the remediation action is initiated.

8. The years in which the costs are assumed to incur are indicated in the implementation schedules, which are discussed later in this section.

10. Excavation costs were based on total estimated volume to be removed including overexcavation.

11. The costs were generated assuming that the waterways and the flood plain would be remediated separately from the wastewater facilities. If both areas are remediated,

some costs could be reduced by using facilities for both sites; for example, water treatment plant and temporary storage facilities.

12. It was assumed that the ash and other incineration wastes would be delisted.

13. Temporary facilities (for example, the water treatment facility were assumed to be cleaned, delisted, and salvaged after their use at this site.

The specific assumptions concerning quantities and methods of implementation were presented in Sections 5 and 6. Estimated unit costs are presented in Appendix C.

SENSITIVITY ANALYSIS

The effect of some key variables on the capital costs was determined. The following parameters were varied:

- Contractor fees for incineration or disposal. The incineration fee (both local and nonlocal) and the fee charged by a nonlocal disposal facility for accepting the waste were varied.

- Haul distance to nonlocal incinerator and to non-local RCRA disposal facility. A range of haul distance of 100 to 500 miles was used. Currently, no offsite facility has indicated it would accept the TCDD-waste from this site.

- Level of Cleanup/Quantity of Material. Waterways and Flood Plain--Two additional levels of cleanup were examined in the sensitivity analysis. One level assumed all the contaminated loose bottom sediment in Rocky Branch and Bayou Meto that was identified in the RI would be removed. Also, those flood plain areas with TCDD levels greater than or equal to 0.25 ppb (about 800 ac) would be remediated.

  The other level of cleanup was 2.5 ppb for the flood plains and waterways. Only the northern section of Rocky Branch and its adjacent flood plain were identified in the RI as having TCDD levels of this magnitude.

  Wastewater Facilities--Most of the contaminated material lies in the sludges of the aeration pond and oxidation basins. The percent solids content is unknown and was varied from 2 to 8 percent for the sensitivity analysis.

The results of the sensitivity analysis are presented in Tables 8-15 and 8-16 for the waterways and the flood plain and the wastewater facilities, respectively.

IMPLEMENTATION SCHEDULE

Figures 8-1 and 8-2 present the estimated implementation schedules for the remedial alternatives for the waterways and flood plain and the wastewater facilities, respectively. The actual schedule for any alternative could vary significantly from the schedule presented. Factors such as permits, facility and equipment availability, and signing of a state Superfund contract could significantly affect schedules.

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Table 8-15
WATERWAYS AND FLOOD PLAIN
SENSITIVITY ANALYSIS

Variable Factor	Capital Cost/Present Worth, $ million						
	No Action	Restrict Access and Monitor Migration	In-Place Containment	Local Incineration	Nonlocal Incineration	Local Disposal	Nonlocal Disposal
Base Case[a]	0	1.6/1.4	4.6/3.8	240/160	220/140	65/49	79/55
Contractor Cost							
Range Incineration: $400-1500/ton Nonlocal Disposal: $50-$300/cy	0[c]	1.6/1.4[c]	4.6/3.8[c]	140-330/90-220	130-300/80-190	65/49[c]	73-100/52-71
Haul Distance to Nonlocal Incineration/ Disposal							
Range 100-500 miles	0[c]	1.6[c]/1.4	4.6[c]/3.8	240[c]/160	220-230/140-150	65/49[c]	66-79/47-55
Level of Cleanup/ Quantity of Material[b]							
0.25 ppb[b]	0[c]	4.8/3.5	86/63	3,200/820	2,900/750	550/370	740/470
2.5 ppb[d]	0[c]	0.89/0.85	2.2/1.9	81/53	73/48	27/20	30/21

[a] The base case was used for developing and evaluating the alternatives. The incineration cost was assumed to be $1,000 per ton; the nonlocal disposal cost $100 per yd^3; the haul distance for nonlocal incineration, 200 miles; the haul distance for nonlocal disposal, 500 miles; the waterways channels sections with TCDD levels greater than or equal to 1 ppb would be remediated, including the banks and adjacent flood plain in these sections.

[b] A cleanup level of 0.25 ppb corresponds to the flood plain. All the contaminated loose bottom sediment in Rocky Branch (9600 ft/4100 yd^3) and Bayou Meto (24,800 ft/53,000 yd^3) which was identified in RI would be removed.

[c] The cost for this alternative is not affected by the variable factor.

[d] This action level was applied to the waterways and flood plain.

Costs are in 1986 dollars.

Table 8-16
WASTEWATER FACILITIES
SENSITIVITY ANALYSIS

		Capital Cost/Present Worth, $ million					
Variable Factor	No Action	Restrict Access, Abandon Facilities, and Monitor Migration	Local Incineration[a]	Nonlocal Incineration[a]	Storage in Wastewater Facilities	Local Disposal[a]	Nonlocal Disposal[a]
Base Case[b]	0	1.9/1.7	A--120/83 B--140/97	A--110/78 B--130/90	57/40	A--61/43 B--63/48	A--71/45 B--76/53
Contractor Cost							
Range Incineration: $400-$1500/ton; Nonlocal Disposal: $50-$300/cy	0[c]	1.9/1.7[c]	A--80-150/55-87 B--90-180/62-130	A--74-140/52-99 B--83-170/58-120	57/40[c]	A--61/43[c] B--63/48[c]	A--67-88/43-54 B--69-95/48-67
Haul Distance to Nonlocal Incineration/Disposal							
Range 100-500 miles	0[c]	1.9/1.7[c]	A--120/83[c] B--140/97[c]	A--110-120/76-82 B--130-140/89-97	57/40[c]	A--61/43[c] B--63/48[c]	A--62-71/40-45 B--65-76/46-53
Solids Content of Wastewater Sludges							
Range 2%-8% solids	0[c]	1.9/1.7[c]	A--70-170/48-120 B--90-190/62-130	A--61-160/43-110 B--80-180/57-130	41-72/29-51	A--42-80/31-54 B--45-82/33-62	A--46-97/31-58 B--50-100/35-71

[a] Costs given without parantheses are for Alternative A--cleaning of sewers--and Alternative B--removal of sewer line and pipe zone material.
[b] The base case was used for developing and evaluating the alternatives. The incineration cost was assumed to be $1,000 per ton; the nonlocal disposal cost, $100 per yd^3; the haul distance for nonlocal incineration, 200 miles; the haul distance for nonlocal disposal, 500 miles; the solids content of the wastewater sludges, 5 percent.
[c] The cost for this alternative is not affected by the variable factor.

Costs are in 1986 dollars.

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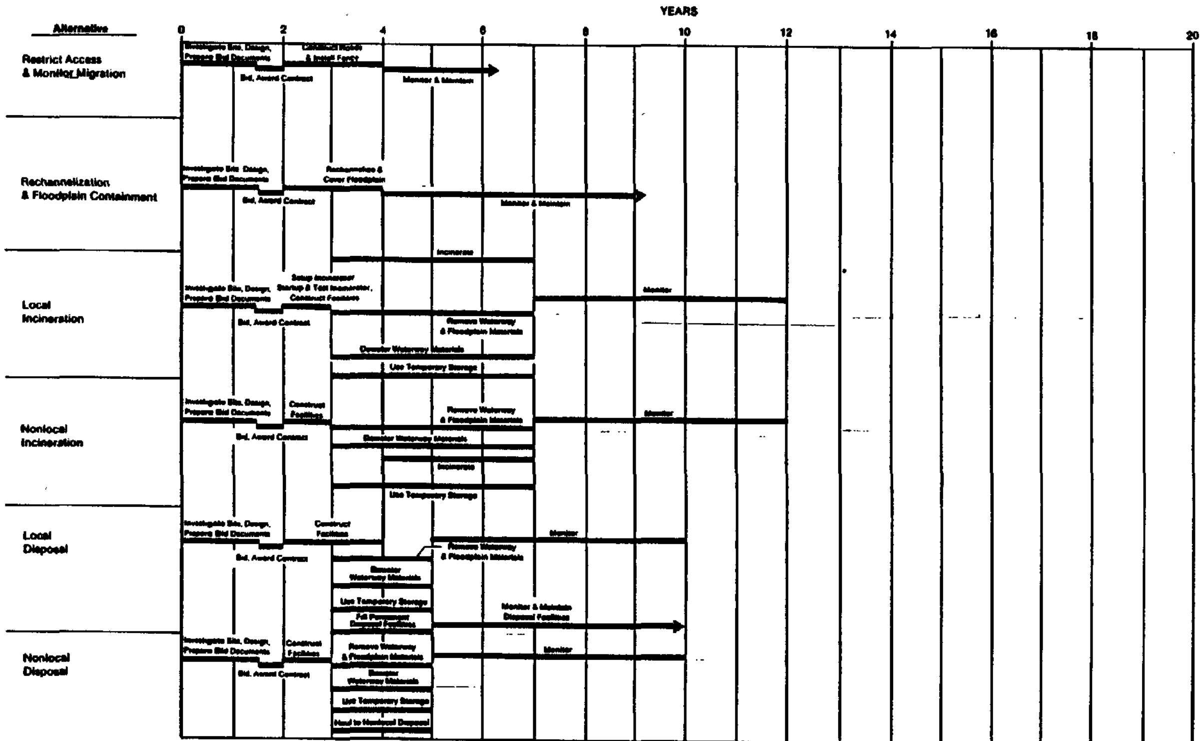

Figure 8-1
Implementation Schedule
Waterways and Floodplain

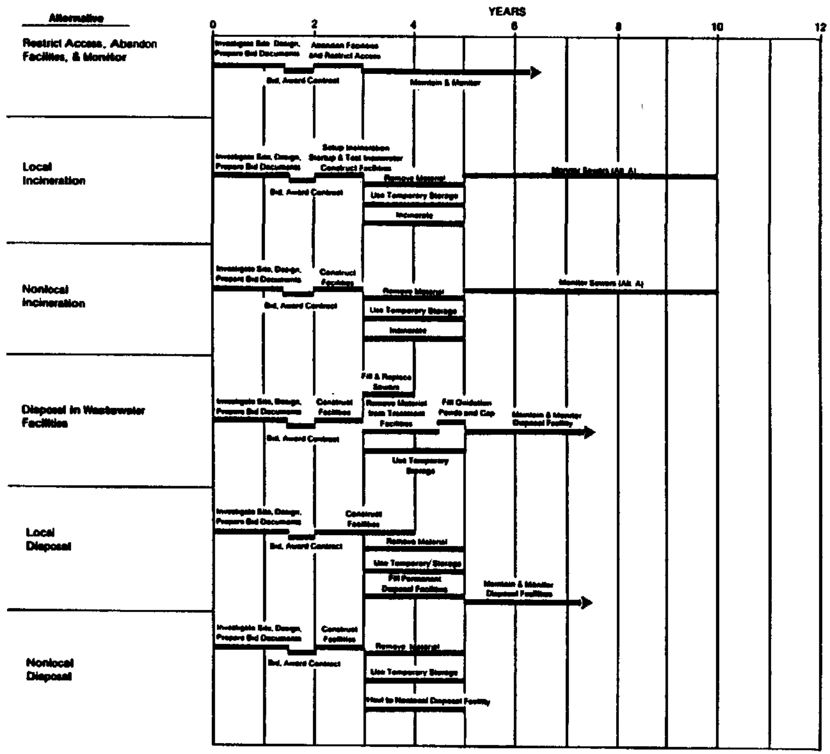

Figure 8-2
Implementation Schedule
Wastewater Facilities

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Section 9
SUMMARY OF ALTERNATIVES

This section gives a brief description of the remedial alternatives that were developed and evaluated for the Vertac offsite TCDD-contaminated areas in Sections 5 through 8. A summary of the evaluations is also presented.

Figure 9-1 summarizes the waste management steps for the seven alternatives developed for the waterways and floodplain. Table 9-1 is a summary of the descriptions and analyses of the alternatives.

Figure 9-2 summarizes the waste management steps for the seven alternatives developed for the wastewater facilities. Table 9-2 is a summary of the descriptions and analyses of the alternatives.

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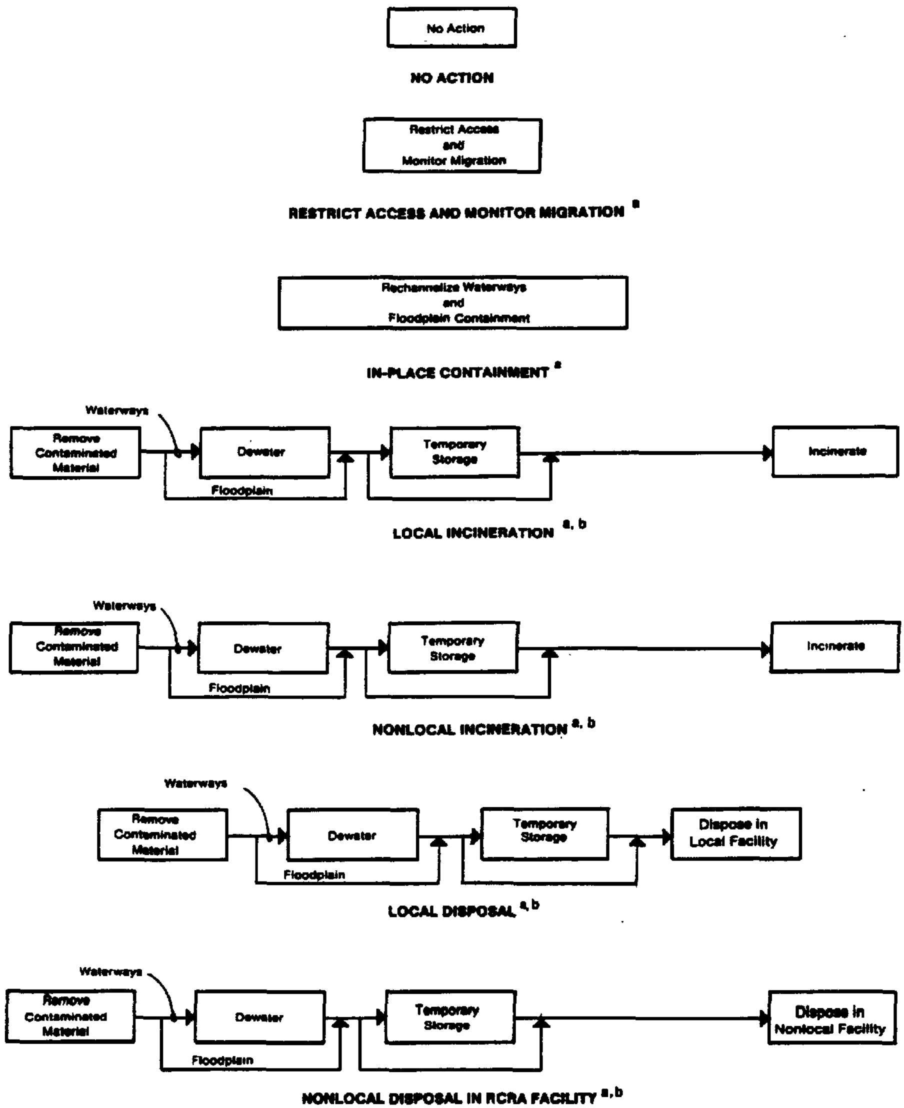

[a] These alternatives include a mobile water treatment facility.
[b] These alternatives include a fixed water treatment facility.

Figure 9-1
Waste Management Steps for Remedial Alternatives
Waterways and Floodplain

Table 9-1
SUMMARY OF REMEDIAL ALTERNATIVES
WATERWAYS AND FLOOD PLAIN

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time,[b] Years	Total Capital Cost, $Million	Total Present Worth, $Million
1. NO ACTION No actions would be taken at the site.	5 - No action	Easiest alternative to implement	Does not reduce exposure to or migration of TCDD	0	0	0
2. RESTRICT ACCESS AND MONITOR MIGRATION Access to waterways and flood plain would be restricted by fences, signs, and public awareness programs. Future extent of TCDD contamination will be monitored by soil/sediment sampling and with wells. LENGTH OF WATERWAYS: Bayou Meto--6,450 ft Rocky Branch--3,700 ft AREA OF FLOOD PLAINS: 23 ac	4 - Meets CERCLA goals but does not meet standards.	More economical and easier to implement than Alternatives 3-7. Deters recreational and agricultural use of creeks and flood plain, thus reducing potential for exposure; deters consumption of contaminated fish, a primary public health concern.	Restricted usage would apply to several miles along the waterways, resulting in a substantial loss of acreage. Land use patterns may change. TCDD-migration into accessible areas--downstream channel, flood plains, and air--is not reduced.	4	1.6	1.4
3. IN-PLACE CONTAINMENT A new channel for part of Rocky Branch and Bayou Meto would be constructed. The contaminated material in the old channel would be buried with soil. The contaminated flood plains would be covered with geotextiles and 12 in. of topsoil. Flood control berms would be constructed to reduce erosion. Long-term maintenance required. LENGTH OF WATERWAYS: Bayou Meto--6,450 ft Rocky Branch--3,700 ft AREA OF FLOOD PLAINS: 23 ac	4 - Meets CERCLA goals but does not meet standards.	Cover reduces exposure of TCDD to public and environment. Reduction in TCDD-bioaccumulation by aquatic life that is consumed by humans. Eventually normal activities can resume in waterways and flood plain.	Placement of geotextile and topsoil around the trees in the flood plain will be difficult. Floodplain will have to be regularly inspected and maintained to prevent uncovering of contaminated soil. Existing aquatic ecosystem and the terrestrial environment will be destroyed within the remediation area.	4	4.6	3.8

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Table 9-1
(continued)

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time, Years[b]	Total Capital Cost, $Million	Total Present Worth, $Million
4. LOCAL INCINERATION The contaminated materials would be removed, the waterway sediments dewatered using windows, and the material incinerated at an incinerator located onsite. Quantity of material (in-place contaminated volumes): Bayou Meto--17,800 yd^3 Rocky Branch--5,700 yd^3 Floodplain--37,600 yd^3	2-attains standards[c]	Destruction of TCDD eliminates potential for future human and environment exposure. No restrictions on future and land use Mobile incinerators have been shown to have TCDD DRE's of greater than 99.9999 percent. These incinerators or ones similar to them would probably be available for use at this site.	Air emissions may present an exposure hazard if destruction of TCDD is incomplete. Public concern about waste incinerator in their "backyard." Removing materials may be difficult due to site conditions including dense forest, no existing roads to most of the contaminated areas, and possibly unstable soils.	7	240	160
5. NONLOCAL INCINERATION The contaminated materials would be removed, the waterway sediments dewatered using windows, and the materials hauled to a nonlocal incineration facility. Quantity of Materials (in-place contaminated volumes): Bayou Meto--17,800 yd^3 Rocky Branch--5,700 yd^3 Floodplain--37,600 yd^3	1-RCRA offsite facility and 2-attains standards[c]	Destruction of TCDD eliminates potential for future human and environment exposure. No restrictions on future land use. Incineration with DRE's greater than 99.9999 percent has been demonstrated.	Air emissions may present an exposure hazard if destruction of TCDD is incomplete. Removing materials may be difficult due to site conditions including dense forest, no existing roads to most of the contaminated areas, and possibly unstable soils. Potential for hazardous waste spillage during hauling increases with haul distance. Currently there is no nonlocal, permanent incinerator which is permitted for TCDD destruction.	7	220	140

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Table 9-1
(continued)

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time,[b] Years	Total Capital Cost, $Million	Total Present Worth, $Million
6. LOCAL DISPOSAL The contaminated materials would be removed, the waterway sediments dewatered using windows, and the materials disposed in an RCRA-design facility built onsite. Quantity of Materials (in-place contaminated volumes): Bayou Meto--17,800 yd^3 Rocky Branch--5,700 yd^3 Floodplain--37,600 yd^3	2-attains standards[c]	Containment effectively removes TCDD from public and environment exposure. No restrictions on future land use. their "backyard".	Failure of disposal facility could result in contamination of adjacent and downstream flood plains. Public concern about disposal facility in their "backyard". Removing materials may be difficult due to site conditions including dense forest, no existing roads to most of the contaminated areas, and possibly unstable soils. Suitability of site for permanent disposal facility is uncertain due to location in floodplain and possibly soil conditions. Future acceptance by regulatory agencies of disposing TCDD wastes is uncertain.	5	65	49
7. NONLOCAL DISPOSAL IN RCRA FACILITY The contaminated materials would be removed, the waterway sediments dewatered using windows, and the materials hauled to a nonlocal disposal facility. Quantity of Materials (in-place contaminated volumes): Bayou Meto--17,800 yd^3 Rocky Branch--5,700 yd^3 Floodplain--37,600 yd^3	1-RCRA offsite facility and 2-attains standards[c]	Containment effectively removes TCDD from public and environment exposure. No restrictions on future land use.	Currently there is no disposal facility permitted to accept TCDD waste. Future acceptance by regulatory agencies of disposing TCDD wastes is uncertain. Removing materials may be difficult due to site conditions including dense forest, no existing roads to most of the contaminated areas, and possibly unstable soils. Potential for hazardous waste spillage during hauling increases with haul distance.	5	79	55

[a] The EPA categories are alternatives that: (1) use a RCRA offsite facility, (2) attain standards, (3) exceed standards, (4) meet CERCLA goals but do not meet standards, and (5) require no action. These categories are further discussed in the "National Oil and Hazardous Substances Contingency Plan" (November 20, 1985, Federal Register).
[b] The implementation time refers to the time from when design of the remedial alternative commences to when the remediation actions are complete--except for ongoing maintenance and monitoring.
[c] These alternatives could fall under EPA categories 3 or 4 by varying the cleanup level. The cleanup level is varied in the sensitivity analysis presented in Section 8.

NOTES:

Costs in 1986 dollars.
Discount rate=10%.

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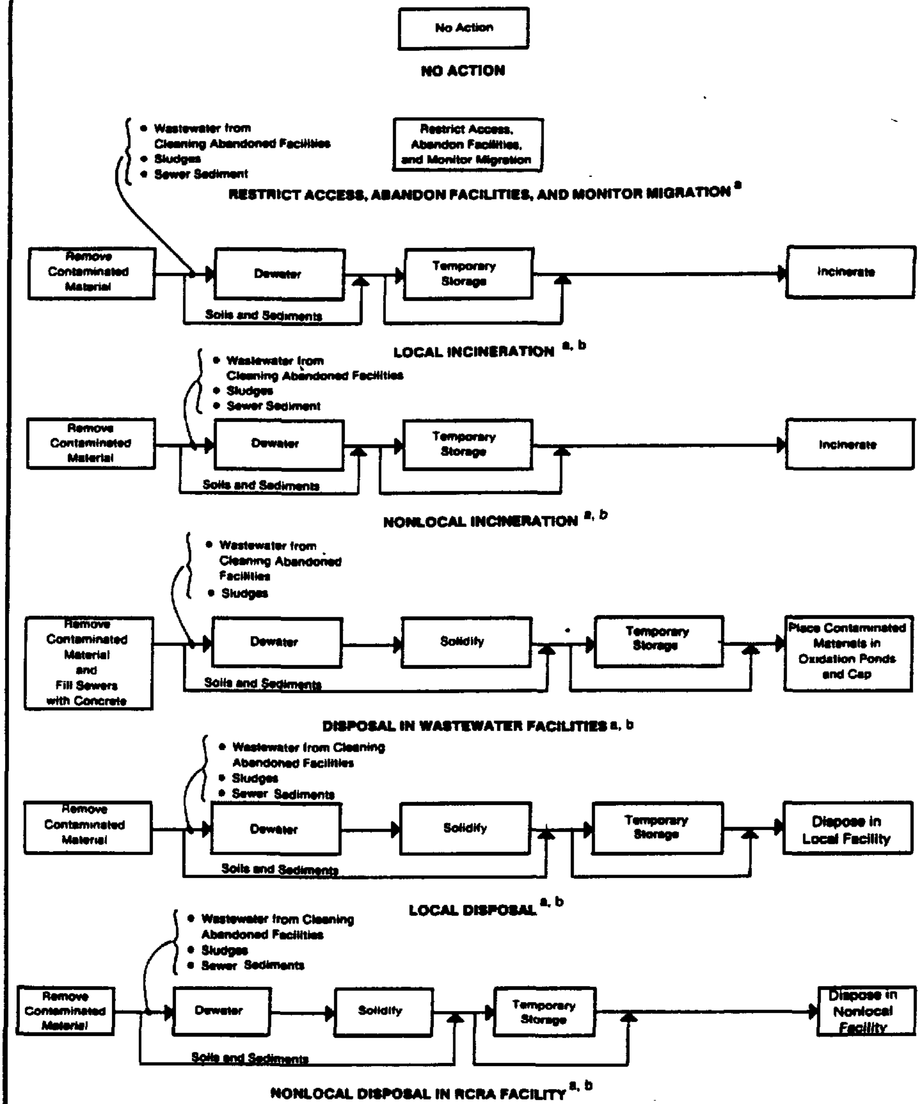

[a] These alternatives include a mobile water treatment facility.
[b] These alternatives include a main water treatment facility.

Figure 9-2
Waste Management Steps for Remedial Alternatives
Wastewater Facilities

009859

Table 9-2
SUMMARY OF REMEDIAL ALTERNATIVES
WASTEWATER FACILITIES

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time, Years[b]	Total Capital Cost[c], $Million	Total Present Worth[c], $Million
1. NO ACTION No actions would be taken at the site.	5 - No action	Easiest alternative to implement.	Does not reduce exposure to or migration of TCDD.	0	0	0
2. RESTRICT ACCESS, ABANDON FACILITIES, AND MONITOR MIGRATION. The sewer lines would be plugged and a new sewer line installed; use of the aeration pond and oxidation basins would be discontinued; access to the old and west sewage treatment plants would be restricted with fencing, signs, and public awareness programs; TCDD-contamination would be monitored with soil/sediment sampling and wells.	4 - Meets CERCLA goals but does not meet standards	More economical and easier to implement than Alternatives 3-7. Potential for human exposure is reduced. Migration of TCDD into the waterways would be reduced.	The possibility of exposure to TCDD via inhalation of airborne TCDD-particulates or consumption of contaminated groundwater is not reduced. Undesirable TCDD-migration may occur undetected.	3	1.9	1.7
3. LOCAL INCINERATION The contaminated materials in the sewer lines would be removed primarily by hydraulic flushing (Alternative A) or by completely removing the sewer line and pipe zone material (Alternative B); the contaminated material in the basins in the old sewage treatment plant would be washed out and the contaminated soil in the drying beds and out-fall ditch removed; the wastewater in the aeration pond and oxidation basins would be pumped out and the outfall ditch excavated. The contaminated sediment/slurries and wastewaters would be dewatered with a polyethylene wedge-wire drying bed system The contaminated materials would be incinerated at a facility located onsite. Quantity of Material to be Incinerated: 33,500 tons (Alt. A) 42,200 tons (Alt. B)	3-exceeds standards	Destruction of TCDD eliminates potential for future human and environment exposure. No restrictions on future use of facilities and land. Mobile incinerators have been shown to have TCDD DRE's of greater than 99.9999 percent. These incinerators or ones similar to them would probably be available for use at this site.	Air emissions may present an exposure hazard if destruction of TCDD is incomplete. Public concern about waste incinerator in their "backyard."	5	120 (140)	83 (97)

009860

Table 9-2
(continued)

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time, Years[b]	Total Capital Cost[c], \$Million	Total Present Worth[c], \$Million
4. NONLOCAL INCINERATION Same as above except contaminated material would be hauled to a nonlocal incinerator facility. Quantity of Material to be Incinerated: 33,500 tons (Alt. A) 42,200 tons (Alt. B)	1-RCRA offsite facility and 3-exceeds standards	Destruction of TCDD eliminates potential for future human and environment exposure. No restrictions on future use of facilities and land. Incineration with DRE's greater than 99.9999 percent had been demonstrated.	Air emissions may present an exposure hazard if destruction of TCDD is incomplete. Potential for hazardous waste spillage during hauling increases with haul distance. Currently there is no nonlocal, permanent incinerator which is permitted for TCDD destruction.	5	110 (130)	70 (90)
5. DISPOSAL IN WASTEWATER FACILITIES Sewer lines would be completely filled with concrete; contaminated materials in old and west sewage treatment plant would be removed and consolidated in a portion of the existing oxidation basins which would be capped. The wastewater sludges would be dewatered and solidified prior to containment in oxidation basins. Length of Sewer line to be Filled: 14,700 ft Quantity of Material to be Stored: 48,000 yd^3	4 - Meets CERCLA goals but does not meet standards.	Risk of TCDD-exposure to public and environment is reduced. Migration of TCDD is reduced, especially into waterways. Use of the aeration pond could possibly be resumed.	Adequacy of site for containing materials underground is unknown. Concerns include being located in flood plain and interactions with soil/groundwater. Long-term maintenance and monitoring of containment facility required. Public objection to disposing hazardous material in their "backyard."	5	57	40
6. LOCAL DISPOSAL Removal methods are the same as for Alter-Alternative 3. Sludges would be dewatered and solidified prior to disposal. Disposal would be in a RCRA-design facility built on or adjacent to contaminated areas. Quantity of Material to be Stored: 48,000 yd^3 (Alt. A) 53,000 yd^3 (Alt. B)	3-exceeds standards	Containment effectively removes TCDD from public and environment exposure. No restrictions of future use of wastewater facilities.	Failure of disposal facility could result in contamination of groundwater and flood plain. Suitability of site for permanent disposal facility is uncertain due to location in flood plain and possibly soil conditions. Future acceptance by regulatory agencies of disposing TCDD wastes is uncertain. Public concern about having disposal facility in their "backyard."	5	61 (63)	43 (48)

Table 9-2
(continued)

Remedial Alternative	EPA Category[a]	Advantages	Disadvantages	Implementation Time, Years[b]	Total Capital Cost[c], $Million	Total Present Worth[c], $Million
7. NONLOCAL DISPOSAL IN RCRA FACILITY Same as above except contaminated material would be hauled to a nonlocal RCRA disposal facility. Quantity of Material to be Stored: 48,000 yd^3 (Alt. A) 53,000 yd^3 (Alt. B)	1-RCRA offsite facility and 3-exceeds standards	Containment effectively removes TCDD from public and environment exposure. No restriction of future use of wastewater facilities.	Currently there is no disposal facility permitted to accept TCDD waste. Future acceptance by regulatory agencies of disposing TCDD wastes is uncertain. Potential for hazardous waste spillage during hauling increases with haul distance.	5	71 (76)	45 (53)

[a]The EPA categories are alternatives which: 1) use a RCRA offsite facility, 2) attain standards, 3) exceed standards, 4) meet CERCLA goals but do not meet standards, and 5) require no action. These categories are further discussed in the "National Oil and Hazardous Substances Contingency Plan" (November 20, 1985, Federal Register).

[b]The implementation time refers to the time from when design of the remedial alternative commences to when the remediation actions are complete--except for ongoing maintenance and monitoring.

[c]When 2 sets of costs are presented for an alternative, the costs without parentheses are for Alternative A (cleaning of sewers in-place) and the costs within parentheses are for Alternative B (removal of sewerline and pipe zone material).

[d]The extent of cleanup of the wastewater facilities assumed in this FS includes removing some soils around the treatment facilities which appear to have TCDD levels of less than 5 ppb. The action level proposed by ATSDR was 1 ppb for this area. However, the assumed increase in cleanup level increases the quantity of material and costs only slightly over that for the cleanup required to conform with ATSDR's recommendations.

Notes: Costs in 1986 dollars.
Discount rate = 10%.

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